URBAN GREEN SPACES AND ITS IMPACT ON QUALITY OF LIFE – A CASE IN CHANDRAPUR CITY

Project Phase-II Report

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Master of Technology In

Urban Planning

by

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I, **Mahi Gajbhiye**, hereby declare that this project titled **"Urban Green Spaces and its Impact on Quality of Life – A Case in Chandrapur city"** is carried out by me in the **Department of Architecture and Planning** of Visvesvaraya National Institute of Technology, Nagpur. The work is original and has not been submitted earlier whole or in part for the award of any degree/diploma at this or any other Institution / University.

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On a concluding note; I am thankful to my parents and for their moral as well as financial support.

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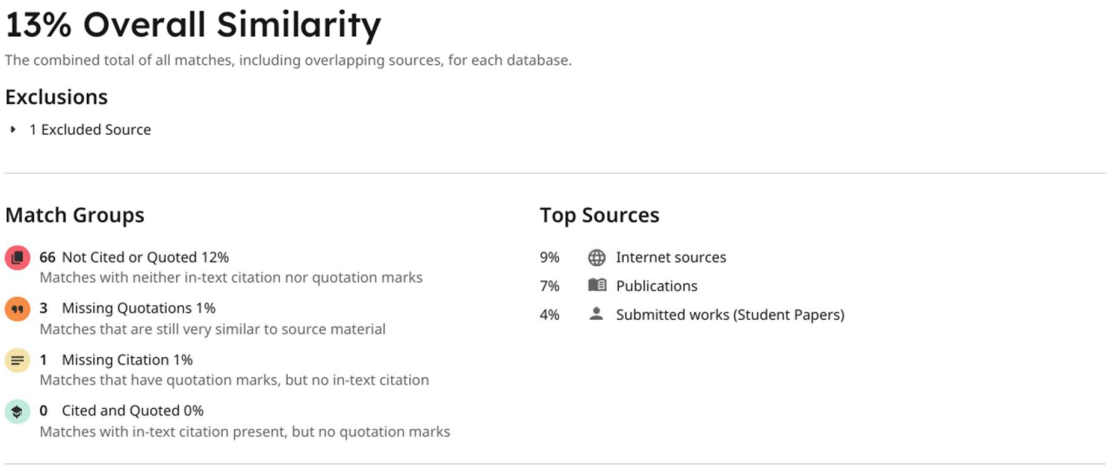
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ABSTRACT

Urban green spaces (UGS) are increasingly recognized as vital elements of sustainable city planning, significantly influencing the well-being of urban populations. This study investigates the spatial distribution and temporal evolution of green spaces in Chandrapur city and examines their relationship with various quality of life (QoL) indicators. Using multi-temporal remote sensing data (1995, 2005, 2015, and 2025), geospatial analyses were conducted to evaluate environmental parameters like NDVI, SAVI, land surface temperature (LST), and water index (NDWI) for the entire city.

Five diverse and vulnerable neighbourhoods; Revenue Colony, Bazaar Ward, Shastri Nagar, Babupeth, and Nirman Nagar—were selected for detailed analysis. Additionally, primary data from household surveys across five neighbourhoods provided insights through interaction with residents of the neighbourhoods. The results revealed a strong positive correlation between the availability of urban greenery and enhanced emotional well-being, physical health, and social interaction.

Chandrapur, a rapidly urbanizing industrial city, faces significant ecological pressures due to coal mining, thermal power plants, and limited green infrastructure. The findings reveal that increased urbanization has led to the degradation of vegetation cover, elevated surface temperatures, and fragmented green networks. This study highlights the critical need for equitable and integrated green space planning in cities like Chandrapur, where urban expansion and environmental degradation coexist. Strengthening UGS networks in Chandrapur can serve as a strategic tool for mitigating pollution, enhancing resilience to climate extremes, and promoting inclusive, liveable neighbourhoods in the face of growing urban challenges.

KEYWORDS: Urban Green Spaces, Chandrapur, Quality of Life, Sustainable Urban Planning, Environmental Indicators, Urbanization

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CHAPTER 1: INTRODUCTION

CHAPTER 1: INTRODUCTION

According to several estimations, by 2050, 70% of the World's population would be living in cities. Approximately one – third population in India started living in cities by 2023. Urbanization is a phenomenon which is observed and felt all over the world. Urbanization presents both opportunities and challenges. While it can drive economic growth and improve standards of living, it also necessitates careful considerations of negative environmental impacts. (World Bank, 2024)

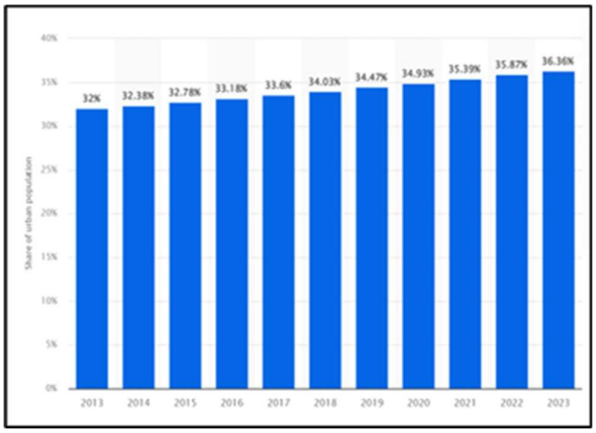


Figure 1:India: Degree of urbanization from 2013 to 2023

This rapid growth of urban population either naturally or through migration has put heavy pressure on physical infrastructure of the cities, like housing, transportation, water supply and sanitation; social infrastructure, health infrastructure, etc. (Rai, 2017). Increasing infrastructural plans require more land, and land in urban areas is limited; and for the consumption the existing green cover is usually affected. Rapid urbanization has often led to decrease in green spaces as the land gets converted into residential, commercial or industrial use.

The relationship between urbanization and green spaces is complex, as the expansion of urban areas often leads to the diminution of natural environments, adversely affecting ecological balance and quality of life. Urban green spaces are increasingly considered a critical asset within the context of sustainability as they are argued to provide with multiple benefits ranging from enriching aesthetics, reducing pollution, enhancing physical health to improving mental health; etc.

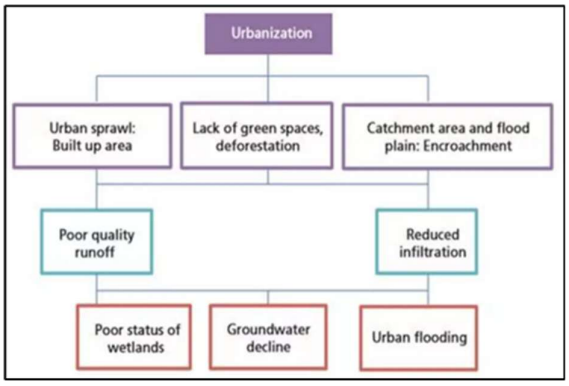


Figure 2:Impact of Urbanization (Vijeta Nigam, 2019)

While urban green spaces offer numerous benefits, their impact on quality of life in India is complex and influenced by several factors. The pressure for urban development and commercialization can threaten green spaces, leading to their conversion for other purposes. Inequality in Access, Lack of adequate funding, resources, and management can lead to the degradation of green spaces, limiting their effectiveness.

1.1 AIM:

To investigate the role of urban green spaces to improve quality of life in neighbourhoods of Chandrapur city.

1.2 OBJECTIVES

(a) To study the concept of urban green spaces and quality of life,

(b) To identify neighbourhoods for the study,

(c) To assess the present scenario of neighbourhood green spaces,

(d) To analyze the parameters of quality of life linked with green spaces.

(e) To propose strategies to improve the quality of life at neighbourhood level.

1.3 METHODOLOGY

The methodology adopted for this study follows a structured and multi-stage approach to comprehensively assess the relationship between urban green spaces and the quality of life in Chandrapur. The process begins with the preliminary stage, which involves identifying the need for the study and establishing its significance in the context of urban development and livability. This stage also includes formulating the aim and specific objectives of the research while clearly defining its scope and limitations to ensure focused outcomes.

Following the preliminary groundwork, a literature study is conducted to build a theoretical foundation. This includes an in-depth review of scholarly work on urban green spaces, the concept of quality of life, and how the two are interrelated. Relevant national and international case studies are analyzed to understand the tools and indicators used for assessing quality of life in urban contexts. Key indicators linked to green spaces are identified, and appropriate tools for measuring these indicators are selected.

The next phase involves the selection of the study area. A set of neighbourhoods within Chandrapur city is chosen based on their urban characteristics and availability of data. For spatial analysis, satellite images from Landsat 5, 7, and 8/9 for the years 1995, 2005, 2015, and 2025 are acquired from the USGS database. Simultaneously, a questionnaire is prepared to support primary data collection through resident surveys, ensuring community input in the analysis.

In the data collection stage, both secondary and primary data are gathered. Land use maps and population data are obtained from the Chandrapur Municipal Corporation. In addition, field surveys are conducted in the selected neighbourhoods to collect insights directly from residents, which complements the spatial data.

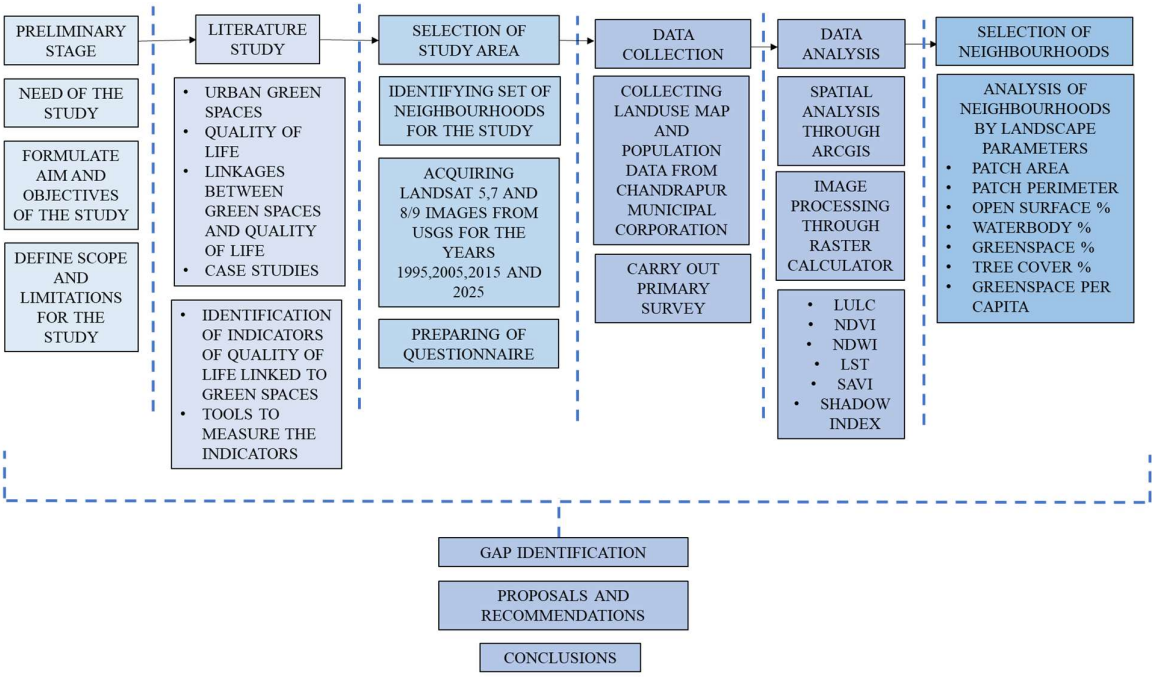
The data analysis component employs geospatial and image processing techniques. Spatial analysis is conducted using ArcGIS to examine the urban landscape and green space distribution. Image processing is carried out through raster calculations to derive several key indices, including Land Use Land Cover (LULC), Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), Land Surface Temperature (LST), Soil Adjusted Vegetation Index (SAVI), and the Shadow Index. These indices help quantify environmental conditions and vegetation dynamics over time.

Based on this processed data, a selection of neighbourhoods is performed using a set of landscape parameters. These include patch area, patch perimeter, open surface percentage, waterbody percentage, greenspace percentage, tree cover percentage, and greenspace per capita. The comparative analysis of these metrics across neighbourhoods enables a better understanding of spatial inequities in access to green spaces.

Finally, the study moves into gap identification, where current shortcomings in green space provision and quality of life indicators are assessed. Based on these gaps, proposals and recommendations are formulated to improve green space planning and policy. The study concludes by summarizing the findings and offering strategies for sustainable urban

development with a focus on enhancing the quality of life through improved green infrastructure.

Table 1: METHODOLOGY CHART (Source: Author)



1.4 SCOPE:

Focus on specific neighborhoods within Chandrapur city, based on urbanization level, distribution and proximity to green spaces.

1.5 LIMITATIONS:

The study will be limited to specific neighborhoods in Chandrapur, which may not represent all urban contexts.

1.6 SUMMARY

The chapter outlines the framework of the study by detailing its objectives to investigate the relationship between urban green spaces and quality of life in Chandrapur. It provides a rationale for selecting the city and neighbourhoods and discusses the methods used, including GIS, remote sensing, and surveys.

CHAPTER 2:
LITERATURE STUDY

CHAPTER 2: LITERATURE STUDY

2.1 INTRODUCTION

This chapter reviews existing literature on urban green spaces (UGS), quality of life (QoL), their interlinkages, and the role of geospatial analysis in evaluating them. It sets the theoretical foundation for the research by discussing historical and policy perspectives, typologies of green spaces, and relevant urban planning frameworks.

2.2 URBAN GREEN SPACES

The World Health Organization (WHO) defines urban green spaces (UGS) as "all urban land covered by vegetation of any kind". This includes all vegetation, regardless of size or function, on both private and public land. The World Health Organization (WHO) recommends that cities should provide 9 sqm of undeveloped (unpaved) open space for every inhabitant. The WHO also suggests designing green area networks so that all residents live within a 15-minute walk to an open space.

As per Urban Greening Guidelines, (MoHUA M. o., 2014), green areas are classified as recreational use in any Master Plan or Development Plan. This use includes parks, botanical gardens, playgrounds, open spaces, water bodies and other natural features.

The percentage of these spaces should be 20% to 25% in metropolitan cities as suggested by UDPFI Guidelines, 1996 of Ministry of Urban Development. URDPFI Guidelines, 2015 suggests 1.2 to 1.4 ha per 1000 persons for metropolitan cities which implies per capita green space of 12-14 m² person. (MoHUA M., 2015)

In Indian cities, the per capita open space availability is 2.7sqm; which is far below the basic standards of WHO (Lahoti, Lahoti, & Saito, 2019).

2.2.1 Timeline of Urban Green Spaces

The countryside features inside a city were originally recognised by Romans Campus Martius Park in Detroit, Michigan, built under Augustus plans for incorporating recreational spaces in a city, was the first urban level green space to be restored into hush parkland. Romans also created Horti, a tiny village in Karnataka.

In 64 AD, after the ancient city of Rome was destroyed by Great Fire, the magnificently landscaped palace of Domus Aurea was built by Nero to embrace nature on a greater scale. It integrated the native ecology and untamed wild in unison. The Roman realised the gravity of

both the civilisation in towns and well-being because of nature in-country and coined the phrase 'rus in urbe'. It has been used ever since then in Britain to signify a rural feature planned in cities.

As an effect of industrialisation, meeting places such as public squares were created. Though, they were escapes to the city lifestyle and only accessed by elites Hence, the gap between cities and country grew. The early 19th century saw an onset of the Romantic Movement in response to these disparities, and later the Non-conformism started soon, the humanitarians and political figures set goals for improved sanitation and green lungs.

In 1833, a report of the select committee was published on Public Walks within the city which led to an increase in the number of public parks by the end of the century. By the end of the 19th century, the Romantics idealised reflective-introspection' while urban developers focused on extra section. In 1902, inspired by this concept of a town being a part of country and country being a part of town, Ebenezer Howard wrote Garden Cities of Tomorrow".

The war years and recession took over the world, and in the post-world-war years (1945-1950) emerged the atrocious motor vehicles. Rise of the concept of 'Green Belt prompted a sound desire to urban sprawl and as a result, even today, the infill development is incurring pressure on urban green spaces of cities.

Automobile imposed an immense burden on natural pedestrian routes, and so, the core of the cities became congested and unwelcoming. In 1991, London took a walker-friendly appeal and proposed a 110 miles long footpath called the Green London Way.

And now cities like Portland and Hengyang have adopted this technique in the form of long linear parks which would form a loop around the city's centre. Today, there is growing recognition for restorative powers of nature amidst the burring cities. (Urban Rambles, 2015)

Terminology	Definition
Greenspace	"A form of common land open to all for lawful exercise."
Green areas	"Open country tract such as open recreational areas, farmland, or woodland of varying width, not necessarily continuous"
Open space	"Any piece of land that is undeveloped."
Recreational spaces	"Place of Any pursuit or leisure-time activity undertaken voluntarily, primarily for pleasure, satisfaction, refreshment or entertainment."
Urban green space	"UGSs include all public open spaces primarily covered by vegetation, which are available for the users either directly or indirectly."
	"Gardens, parks, informal greenspaces or recreation venue as a unit of UGS are an integral part of any urban area and possess their importance of maintaining the environmental quality."
UGS	"Space possess the property of active or passive recreation, or indirect benefits serving the needs of people and enhancing the life quality in cities or urban regions."
Urban green	"Public spaces in conjunction with squares, gardens, parks, allotments or cemeteries and natural areas set within the urban fabric."
Green space	"Acknowledged levels of greenness, explicitly by use, ecosystem services (where the ecosystem service contribution defines green space), green areas, land use and vegetated areas" are the type for the identification of greenspace.
Urban greenspace	"Urban greenspace can comprise a single element (a street tree), as well as a combination of elements (a park with lawns, trees, and ponds), and its character can be natural, semi-natural or manmade."

Figure 3:Evolution of Terminology and Definition of Greenspace (Source: Akanksha Sangwan, 2021)

2.2.2 Typology of Urban Green Spaces in India

2.2.2.a. Urban Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2014

The URDPFI guidelines recommend a minimum of 10 to 12 square meters of open space per person, emphasizing the need for parks, recreational facilities, and other green areas. The guidelines categorize greenspaces based on population size, defining organized greenspaces that include: Recreational Facilities include Parks, playgrounds, sports centres. Natural Features include Water bodies and ecological zones. Community Spaces include Sector-level parks and community gardens.

2.2.2.b. Urban Green Guidelines, 2014

This document categorizes urban green spaces by their ecological functions and benefits. It emphasizes the importance of integrating biodiversity into urban planning. The guidelines suggest that urban residents should have access to public green spaces of at least 0.5 to 1 hectare, promoting multifunctional use of these areas.

2.2.2.c. Atal Mission for Rejuvenation and Urban Transformation (AMRUT), 2015

AMRUT outlines components for developing green spaces as part of urban rejuvenation projects. It encourages the creation of parks and the rejuvenation of water bodies. The mission allocates specific percentages of project funding for green space development, ensuring financial support for these initiatives.

2.2.2.d. National Mission for Green India (GIM)

Focus on Urban Ecosystems: This mission aims to enhance forest cover and improve ecosystem services in urban areas, promoting the integration of green spaces within city planning frameworks.

2.2.2.e. Smart Cities Mission (SCM)

Strategic Planning for UGS: The SCM emphasizes the need for strategic-level planning that includes elements such as quantity, accessibility, multifunctionality, and connectivity of urban green spaces. It aims to integrate UGS into broader urban transformation plans.

2.3 QUALITY OF LIFE

Quality of life (QoL) is a complex concept encompassing various aspects of well-being, including psychological, economic, social, environmental, and physical dimensions. It is a global concept with diverse interpretations and frameworks. While some scholars emphasize activity level or functional status as key dimensions of QoL, others view these as specific indicators of broader QoL components (Aqtam, Ayed, & Zaben, 2023).

The World Health Organization (WHO) defines quality of life as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns." This definition highlights the subjective nature of QoL, acknowledging the influence of personal and cultural factors on one's sense of well-being.

The concept is widely applied in fields such as psychology, healthcare, and urban planning to evaluate and enhance individual and community well-being. It incorporates both objective and subjective approaches. The WHOQOL assessment, developed by the WHOQOL Group in collaboration with 15 international field centres, aims to provide a cross-culturally applicable measure of QoL.

2.3.1 Historical Background of QoL

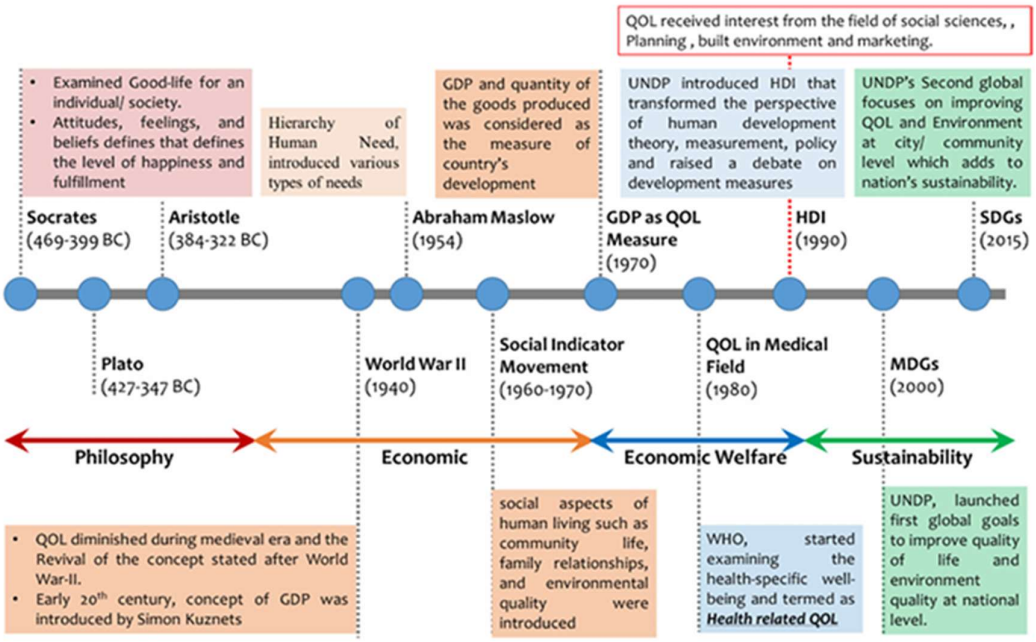

QOL received interest from the field of social sciences, , Planning , built environment and marketing.
Examined Good-life for an individual/ society.
Attitudes, feelings, and beliefs defines that defines the level of happiness and fulfillment
Hierarchy of Human Need, introduced various types of needs
GDP and quantity of the goods produced was considered as the measure of country's development
UNDP introduced HDI that transformed the perspective of human development theory, measurement, policy and raised a debate on development measures
UNDP's Second global focuses on improving QOL and Environment at city/ community level which adds to nation's sustainability.
Socrates (469-399 BC)
Aristotle (384-322 BC)
Abraham Maslow (1954)
GDP as QOL Measure (1970)
HDI (1990)
SDGs (2015)
Plato (427-347 BC)
World War II (1940)
Social Indicator Movement (1960-1970)
QOL in Medical Field (1980)
MDGs (2000)
Philosophy
Economic
Economic Welfare
Sustainability
QOL diminished during medieval era and the Revival of the concept stated after World War-II.
Early 20th century, concept of GDP was introduced by Simon Kuznets
social aspects of human living such as community life, family relationships, and environmental quality were introduced
WHO, started examining the health-specific well-being and termed as Health related QOL
UNDP, launched first global goals to improve quality of life and environment quality at national level.

Figure 4:Historical Perspectives of Quality of Life: A Timeline (Source: (Yadav & Gupta, 2021))

The beginning of the QoL concept can be traced back from the era of the early philosophical period (427- 322 BC); and happiness was the central objective of a good-life and defined by attitudes, feelings, and beliefs.

2.3.2 Quality of life indicators

Quality of life measured objectively: Objective quality of life denotes quantifiable external elements that can be measured and evaluated regardless of individual emotions or beliefs. These metrics frequently encompass: Economic Elements includes Income rates, job situation, and assets. Health Metrics includes Physical wellbeing measures, availability of medical services, incidence of illness. Living Standards includes Quality of housing, availability of clean water, sanitation facilities, and environmental factors. Social Indicators includes educational attainment, criminal activity, and local resources.

In research, objective measures are commonly utilized to evaluate the efficacy of policies/ interventions. They offer a factual foundation for assessing living conditions, but might not completely reflect a person's individual experience or satisfaction with those circumstances.

Quality of Life from a Subjective Perspective: In contrast, subjective quality of life includes individual perceptions and assessments of one's life situation. This aspect is fundamentally personal and can differ greatly between various individual. Essential elements consist of:

Life Satisfaction includes general happiness with life in its entirety. Emotional Health includes States of joy, sorrow, pressure, and worry. Social Connections includes the perceived nature of relationships with relatives, acquaintances, and the community. Personal Satisfaction includes the extent to which individuals believe they have realized their personal objectives and dreams.

Subjective evaluations are generally measured using surveys or questionnaires that prompt individuals to evaluate their contentment with different facets of life. Studies show that objective conditions can affect subjective wellbeing; nonetheless, the connection is intricate. For example, people in comparable situations may express significantly different degrees of satisfaction because of their individual perceptions, expectations.

Figure 5:Urban Quality of Life (UQoL) – Source: (Yadav & Gupta, 2021)

The Urban Quality of Life (UQoL) is a multifaceted concept composed of three primary components: People, Place, and Perception.

People: This component focuses on individual well-being and satisfaction.

Place: This component refers to the objective conditions of an area, such as infrastructure, environment, and amenities.

Perception: This component reflects how individuals perceive and value the objective conditions of their environment.

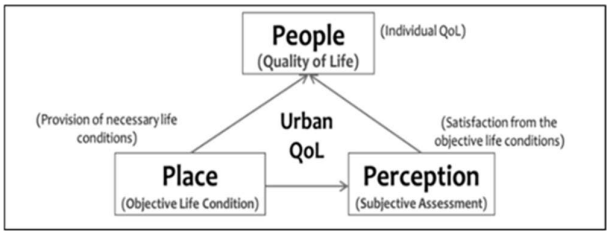


Figure 6: Urban QoL – Source: (Yadav & Gupta, 2021)

As human needs evolve and become increasingly diverse, assessing quality of life (QoL) becomes more complex. Urban quality of life (UQoL) has emerged as a framework to address the challenges faced by urban populations and promote healthy, liveable cities.

2.4 LINKAGES BETWEEN URBAN GREEN SPACES AND QUALITY OF LIFE

Urban green spaces, such as parks, gardens, and tree-lined streets, are vital for enhancing urban quality of life. These green areas offer numerous benefits for both individuals and communities, making them essential components of a live-able city.

Studying the relationship between urban green spaces and quality of life is crucial as it highlights how access to these areas significantly impacts residents' physical and mental health, social well-being, and overall satisfaction with life. This understanding is essential for urban planning and design aimed at promoting healthy living and improving community quality of life. It also necessitates an examination of factors such as accessibility, design, and usage of green spaces, which contribute to these benefits. (Jain, 2024).

Urban green spaces not only facilitate physical activity but also serve as venues for social interactions, thereby fostering community cohesion and enhancing overall happiness. the design and quality of these spaces play a pivotal role in determining their effectiveness in promoting health benefits, with well-maintained areas showing stronger associations with positive outcomes. (Addas, 2023)

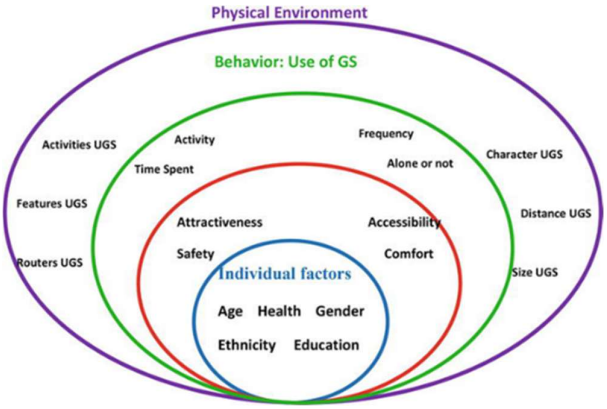


Figure 7: A socio- ecological model for the use of UGS

2.5 INDICATORS OF QUALITY OF LIFE LINKED WITH URBAN GREEN SPACES

The indicators have been selected on the basis of literature study. All the selected indicators are directly or indirectly influenced by the presence, quality, and distribution of green spaces. They reflect the multidimensional benefits of urban greenery, spanning environmental, social, and health-related domains of quality of life.

Table 2: Selected indicators through literature study (Source: Author)

Indicator	Quality of Life Domain	Link to Green Spaces	Benefits
1. Safety	People	Well-maintained parks increase perceived safety. Poorly lit/neglected areas do the opposite.	Encourages usage, reduces crime, supports community policing.
2. Accessibility	Place	Proximity and ease of access to green areas improve equitable use.	Promotes physical activity, social interaction, reduces inequality.
3. Number of Urban Parks	Place	More parks mean more opportunities for recreation and rest.	Enhances urban liveability, supports physical and mental health.
4. Emotional Health	People	Exposure to nature reduces stress, anxiety, and depression.	Improves mental restoration and emotional resilience.
5. Social Relations	People	Parks serve as communal gathering spaces.	Fosters social cohesion, inclusivity, and sense of belonging.
6. Physical Health	People	Encourages active lifestyles (walking, jogging, sports).	Reduces risk of obesity, diabetes, heart disease.
7. Open Surface	Environment	Refers to unbuilt areas available for greenery and public use.	Helps reduce flooding, supports recreation and biodiversity.
8. Total Tree Cover	Environment	Trees contribute to air purification, cooling, and aesthetic value.	Mitigates urban heat island effect, improves air quality and mood.
9. Waterbody	Environment	Lakes, ponds, and rivers enhance park value and biodiversity.	Supports recreation, ecological balance, and microclimate regulation.
10. Greenspace per Capita	Environment	Direct measure of green space availability per person.	Linked to fairness in urban design, health equity, and environmental justice.

2.6 GEOSPATIAL ANALYSIS

Geospatial analysis was carried out using ArcGIS software. The satellite images were processed using various spectral bands, and raster calculations were performed to generate thematic maps. Several environmental indices were derived to assess vegetation, surface temperature, and water content, including:

a. **Land Use Land Cover (LULC):** Land Use Land Cover maps were generated using supervised classification methods. Training samples for various land cover types such as vegetation, built-up, water bodies, and barren land were collected using high-

resolution reference images and field data. The Maximum Likelihood Classification (MLC) algorithm was applied using the Image Classification toolbar in ArcGIS.

b. **Normalized Difference Vegetation Index (NDVI):** NDVI was calculated to assess vegetation health and density. The index uses the red and near-infrared (NIR) bands as follows:

   NDVI = (NIR - RED) / (NIR + RED)

   Band References:

   Landsat 5/7: NIR = Band 4, RED = Band 3

   Landsat 8/9: NIR = Band 5, RED = Band 4

c. **Normalized Difference Water Index (NDWI):** To identify water bodies, NDWI was calculated using the green and NIR bands:

   NDWI = (GREEN - NIR) / (GREEN + NIR)

   Band References:

   Landsat 5/7: GREEN = Band 2, NIR = Band 4

   Landsat 8/9: GREEN = Band 3, NIR = Band 5

d. **Land Surface Temperature (LST):** LST estimation involved a multi-step approach:

   i. Conversion of Digital Number (DN) to Top of Atmosphere Radiance:
      $L = ML \times Qcal + AL$

   ii. Conversion of Radiance to Brightness Temperature (TB):
      $TB = K2 / \ln (K1 / L + 1)$

   iii. Land Surface Temperature Calculation (corrected for emissivity):
      $LST = TB / [1 + (\lambda \times TB / \rho) \times \ln(\varepsilon)]$

   Where:

   λ = Effective wavelength (~10.895 μm for Landsat 8)

   $\rho = hc/\sigma \approx 1.438 \times 10^{-2}$ m·K

   ε = Surface emissivity

e. **Soil Adjusted Vegetation Index (SAVI):** SAVI was calculated to correct NDVI for the influence of soil brightness, particularly in sparsely vegetated areas:

   SAVI = ((NIR - RED) × (1 + L)) / (NIR + RED + L), where L = 0.5

   Band References:

   Landsat 5/7: NIR = Band 4, RED = Band 3

Landsat 8/9: NIR = Band 5, RED = Band 4

f. **Shadow Index**: The Shadow Index was used to detect shaded areas with low reflectance across visible bands. It was computed using the RMS of RGB bands:

   Shadow Index = sqrt ($Blue^2 + Green^2 + Red^2$)

   Band References (Landsat 8/9): BLUE = Band 2; GREEN = Band 3; RED = Band 4

These indices provided a comprehensive understanding of the spatial and temporal dynamics of land cover and environmental quality.

2.7 CASE STUDIES

2.7.1 Urban Neighborhood Green Index: A Measure of Green Spaces in Urban Areas

Location: East Delhi, India

The study presented in this case introduces the Urban Neighbourhood Green Index (UNGI), a tool for assessing and quantifying green spaces at the neighbourhood level in urban areas. Developed to aid planners and administrators, the UNGI incorporates parameters like the Green Index (GI), proximity to green areas, built-up density, and building heights, leveraging remote sensing and GIS technologies. The research focuses on East Delhi, a region with mixed development, ranging from unauthorized high-density zones to planned low-rise and high-rise areas. Analysis reveals that while low-rise, low-density areas have similar GI values to high-rise ones, their UNGI scores are higher, highlighting the critical role of green distribution and urban density in green quality assessment.

UNGI surpasses traditional GI measures by addressing spatial distribution and vertical urban dimensions, providing actionable insights for urban greening strategies. Its simplicity, reliance on accessible data, and adaptability make it a valuable tool for sustainable urban planning, emphasizing the need for better green distribution, especially in high-rise neighbourhoods, to maintain environmental quality. (Gupta, Kumar, Pathan, & Sharma, 2012)

2.7.2 Identifying the domains and factors influencing perceived Quality of Life (QoL) of Indian elderly in the context of their neighbourhoods: a case study of Kolkata, India

The case study examines the factors and domains influencing the perceived Quality of Life (QoL) among elderly individuals in Kolkata, India. Given the unique socio-cultural and economic contexts of South Asia, the study highlights the need for QoL assessment models tailored to the region rather than relying on Western frameworks. It identifies seven broad

domains and 37 associated factors shaping QoL for the elderly, including health, social relationships, independence, and financial stability.

The research methodology incorporates a comprehensive review of existing QoL measurement tools, focus group discussions, and structured surveys involving 408 elderly participants.The findings emphasize that perceived QoL in Indian elderly deviates significantly from Western models, underscoring the necessity of culturally specific frameworks. These insights provide a foundation for developing policies and urban infrastructure to enhance the QoL of the elderly, aligning with their preferences and socio-cultural realities. (Saha, Basu, & Pandit, 2021)

2.7.3 Assessing Public Open Spaces: A Case of Nagpur, India

The case study evaluates public open spaces (POSs) in Nagpur, India, using a proposed Public Open Space Index (POSI). The study, focusing on two public parks, identifies strengths and deficiencies influencing their usage and quality. Key strengths include social cohesion, accessibility, and basic amenities, while weaknesses lie in poor environmental sustainability practices, lack of inclusiveness, and inadequate climate-responsive designs.

Employing mixed methods such as surveys and observations, the study measures five aspects: Individual Well-being, Inclusiveness, Engagement, Sustainability, and Management. The findings reveal that both POSs offer social and economic benefits, such as enhancing local businesses and reducing user health expenditures. However, issues like traffic noise, lack of universal design, and insufficient safety measures hinder their full potential.

The research emphasizes the necessity of inclusive, functional, and sustainable POSs in urban planning. It highlights that addressing these gaps can significantly enhance user satisfaction and urban quality of life, aligning with the goals of sustainable development. This framework serves as a valuable tool for policymakers to design POSs that cater to diverse urban populations effectively. (Ahirrao & Khan, 2021)

2.8 SUMMARY

The chapter synthesizes various definitions, standards, and typologies of UGS from WHO and Indian urban planning guidelines. It also explores the QoL framework and its multifaceted nature. The literature indicates a strong positive correlation between UGS and QoL, reinforcing the study's core hypothesis. Geospatial tools are presented as effective in analyzing environmental and urban changes over time.

CHAPTER 3: ABOUT CITY

CHAPTER 3: ABOUT CITY

3.1 INTRODUCTION

This chapter provides an overview of Chandrapur city, including its history, geography, climate, demography, and urban infrastructure. It establishes why Chandrapur is a suitable case study for analyzing the dynamics of green spaces amid rapid urbanization.

3.2 INTRODUCTION TO STUDY AREA

Chandrapur (earlier known as Chanda, the official name until 1964) is a city and a municipal corporation in Chandrapur district, Maharashtra state, India. It is the district headquarters of Chandrapur district. Chandrapur is a fort city founded by Khandkya Ballal Shah, a Gond king of the 13th century. (Deogaonkar, 2007) The city sits at the confluence of the Erai River and Zarpat river. The area around the city is rich in coal seams. Hence, Chandrapur is also known as the "Black Gold City". (Gunjalkar, 2020)

3.3 LOCATION OF CHANDRAPUR CITY

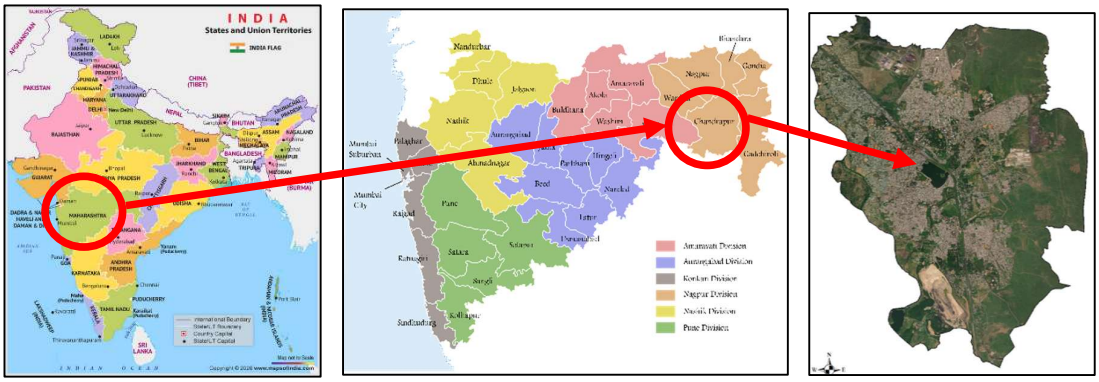


Figure 8: Location of city

Chandrapur is located in central India in the eastern part of Maharashtra state at 19.57°N latitude and 79.18°E longitude. Chandrapur is situated at 189.90 meters above the mean sea level. The area of the city is about 162.41 km^2. The north–south length of the city is about 15.90 km, while the east–west length is about 10.90 km. The city slopes from the north to the south. (Chandrapur Demography)

Chandrapur lies at the confluence of the Erai and Zarpat rivers. The Erai river has a history of flooding. Flood marks are seen on the walls of the city. In the north of the city, a dam is constructed on the river Erai, having the capacity of 207 million cubic meters. The Gaontideo

Nala originates from the uplands of the Chandrapur Super Thermal Power Station. The Macchhi Nala originates from uplands of Central Forest Rangers College.

Chandrapur lies on terrain rich in coal. Chandrapur is called a "geological museum" as there is a large variety of rocks as well as commercially valuable minerals and fossils. Samples of such rocks are collected at the Suresh Chopane Rock Museum. (The Maharashtra Airport Development Company Limited (MADC), n.d.)

3.4 HISTORY

The founding legend of Chandrapur, is rooted in the legend of Chanda Kingdom's king Khandkya Ballal Sah (1437-62 CE) of Sirpur, who was afflicted with tumors. Guided by his wife, he relocated to the Wardha River's north bank, establishing Ballarpur. During a hunt, he discovered a spring on the Zarpat River's dry bed, its waters miraculously healing his ailment. Upon further investigation, the spring revealed cow footprints in rock, deemed a holy site, "Tirtha of Acalesvar", the Achaleshwar Temple group in Chandrapur was erected there after the deity appeared to the king in a dream. Later, witnessing a hare chase his dog, the king, following his wife's advice, founded a fortified city, Chandrapur, avoiding the spot where the hare was killed, deemed unlucky. This narrative combines myth and local lore to explain the city's establishment and the significance of its sacred spring.

Figure 9: Visuals of Chandrapur City

3.5 CONNECTIVITY OF THE CITY

Chandrapur lies on major state highways MH MSH 6, MH MSH 9 and state highways MH SH 233, MH SH 243 and MH SH 264. Chandrapur is connected to many cities in Maharashtra by the Maharashtra State Road Transport Corporation bus service. Bus services are offered to Pune, Nagpur, Amravati, Yavatmal, Hyderabad, and Raipur.

Chandrapur railway station is managed by the Nagpur CR railway division of the Central Railway. It lies on the New Delhi–Chennai main line. The Chanda Fort railway station is managed by the Nagpur SEC railway division of the South East Central Railway. It lies on the Balharshah–Gondia line. Other railway stations within city limits are Vivekanand Nagar railway station, Babupeth railway station and Choti Padoli railway station.

3.6 CLIMATE

Chandrapur has a hot and dry climate. December is the coldest month, with a minimum average temperature of 9 °C and a maximum average temperature of 23.2 °C. May is the hottest month with a mean maximum temperature of 43 °C and a mean minimum temperature of 28.2 °C. On 2 June 2007, Chandrapur recorded the highest temperature of 49 °C and the lowest temperature of 2.8 °C. was recorded in January 1899 & 2021. The monsoon season falls between June and September. Chandrapur's average annual rainfall is 1249.4 mm. The average number of rainy days is 59.2. (India Meteorological Department, 2014)

3.7 DEMOGRAPHY

Population of Chandrapur in 2011 was 3,20,379. The current estimate population of Chandrapur city in 2025 is 4,66,000. (Chandrapur Population 2025, n.d.). In education section, total literates in Chandrapur city are 258,463 of which 138,036 are males while 120,427 are females. Average literacy rate of Chandrapur city is 89.42 percent of which male and female literacy was 93.45 and 85.21 percent. The sex ratio of Chandrapur city is 953 per 1000 males. Child sex ratio of girls is 914 per 1000 boys.

Hinduism is majority religion in Chandrapur city with 71.84 % followers. Buddhism is second most popular religion in Chandrapur city with 15.64 % following it. In Chandrapur city, Islam is followed by 10.07 %, Christianity by 0.94 %, Jainism by 0.54 % and Sikhism by 0.44 %. Around 0.47 % stated 'Other Religion', approximately 0.05 % stated 'No Particular Religion'. (Chandrapur Population 2025, n.d.)

3.8 WIND FLOW DIRECTION

The prominent wind direction is from south to north. In summer the wind direction is from east to south and monsoon from south to east. During winter, the wind direction changes from north to east frequently is characterized by blowing of wild and violent winds heralding the approach of hot season which last till middle of June. (MPCB, 2022)

3.9 GREENS OF CHANDRAPUR

Due to the fact that part of the Tadoba forest falls in the Chandrapur Municipal Corporation area, there is a lot of trees here. There is a lot of vegetation in the outskirts of the metropolitan area but not much in the centre of the city and in the densely populated areas. Due to the existence of coal mines in the area, it is also necessary to increase the green area in the urban areas due to the high level of pollution.

Table 3: Green cover in Chandrapur (33% GREEN COVER DEVELOP ACTION PLAN-MAZI VASUNDHARA 2.0, 2021-2022)

Sr. No	Description	Area cover
1	Chandrapur City Area Sq./Km	56.40 Sq./Km
2	Total All Tree Count as per Tree Census	926414 Trees
	Note – Average Tree Canopy 16 Sq./Meter	
3	Tree Canopy Green Cover	14.82 Sq./Km

Garden Area Green Cover

Sr. No.	Description	Area
1	Total Garden Area	95926 Sq./M
2	Total Garden Green Cover Area	0.095 Sq./Km

3.10 WHY CHANDRAPUR

Maharashtra has an urbanization rate of 48.8%, making it one of the top highly urbanized states in India. Maharashtra's urbanization is higher than Karnataka, Punjab, Haryana and Uttar Pradesh. Unlike Delhi or Tamil Nadu, which are already saturated urban landscapes, Maharashtra presents a mix of developed metro areas and expanding smaller cities, offering diverse urban green space dynamics. Maharashtra also faces deforestation, air pollution, and loss of open spaces due to rapid urban expansion.

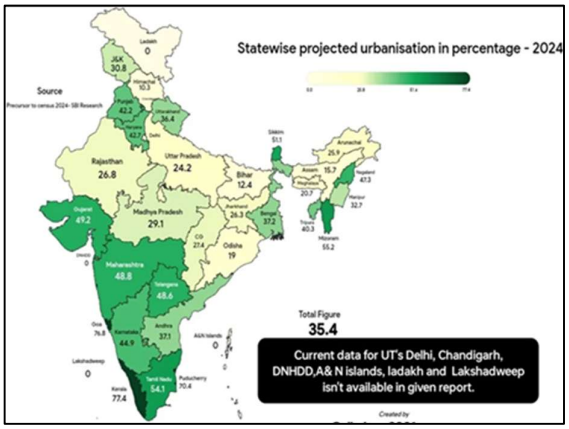


Figure 4: Urbanisation rate in India (Source: SBI Reports)

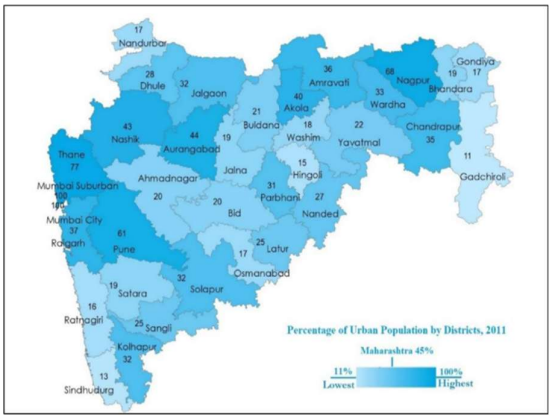


Figure 5: Urbanization rate in Maharashtra (UNICEF, 2011)

Highly urbanized cities like Mumbai (100%), Thane (77%), Pune (61%), and Nagpur (68%) are already taking effort green infrastructure. Chandrapur (35%) is rapidly urbanizing, meaning (UNICEF, 2011)it is at a critical stage where green space planning can still influence urban development. Chandrapur is classified as a pollution hotspot by the Maharashtra Pollution Control Board (MPCB), high pollution negatively impacts health and quality of life, making urban green spaces even more critical for mitigation. Chandrapur has fewer planned urban green spaces and faces pressure due to industrial expansion. Chandrapur has seen a lot of environmental changes in the past four decades which has been studied further. For the study various parameters have been considered.

Chandrapur lies on terrain rich in coal. Chandrapur is called a "geological museum" as there is a large variety of rocks as well as commercially valuable minerals and fossils. Chandrapur has one of the highest pollution levels in Maharashtra, mainly from:

a. Chandrapur Super Thermal Power Station (CSTPS).
b. Coal mining and cement industries.

Chandrapur falls under Maharashtra's Smart Cities Mission, which includes: Urban Forest Development Programs, Green Infrastructure Policies to balance industrial growth with sustainability, Pollution Control Initiatives that promote tree plantation and park development.

3.11 SUMMARY

Chandrapur is a rapidly urbanizing city with high industrial activity and environmental stress. It has significant ecological diversity but lacks well-distributed green infrastructure. Its inclusion in national urban development missions like Smart Cities makes it a critical site for sustainable planning. This chapter justifies its selection for the research.

CHAPTER 4: DATA COLLECTION AND ANALYSIS

CHAPTER 4: DATA COLLECTION AND ANALYSIS

4.1 INTRODUCTION

This chapter details the data sources, methods of data collection, and the analytical techniques used, including remote sensing, GIS-based indices (NDVI, SAVI, LST, NDWI), and field surveys. It introduces the five neighborhoods selected for in-depth analysis.

4.2 METHODOLOGY

This study employs a systematic approach to analyze the dynamics of urban green space and environmental parameters in different neighbourhoods over a 30-year period using remote sensing and GIS tools. The research focuses on a specific urban area within Chandrapur city. The study utilizes Landsat satellite imagery (Landsat 5, 7, and 8/9) obtained from the United States Geological Survey (USGS) for four distinct years: 1995, 2005, 2015, and 2025. These multi-temporal images enable the analysis of long-term environmental changes. Additionally, a questionnaire was prepared to facilitate primary data collection and incorporate public perception into the analysis. Data was collected from both secondary and primary sources. Land use maps and population data were obtained from the Chandrapur Municipal Corporation. To complement this, a primary survey was conducted using the prepared questionnaire to gather on-ground insights and validate satellite data interpretations.

4.3 LULC MAP

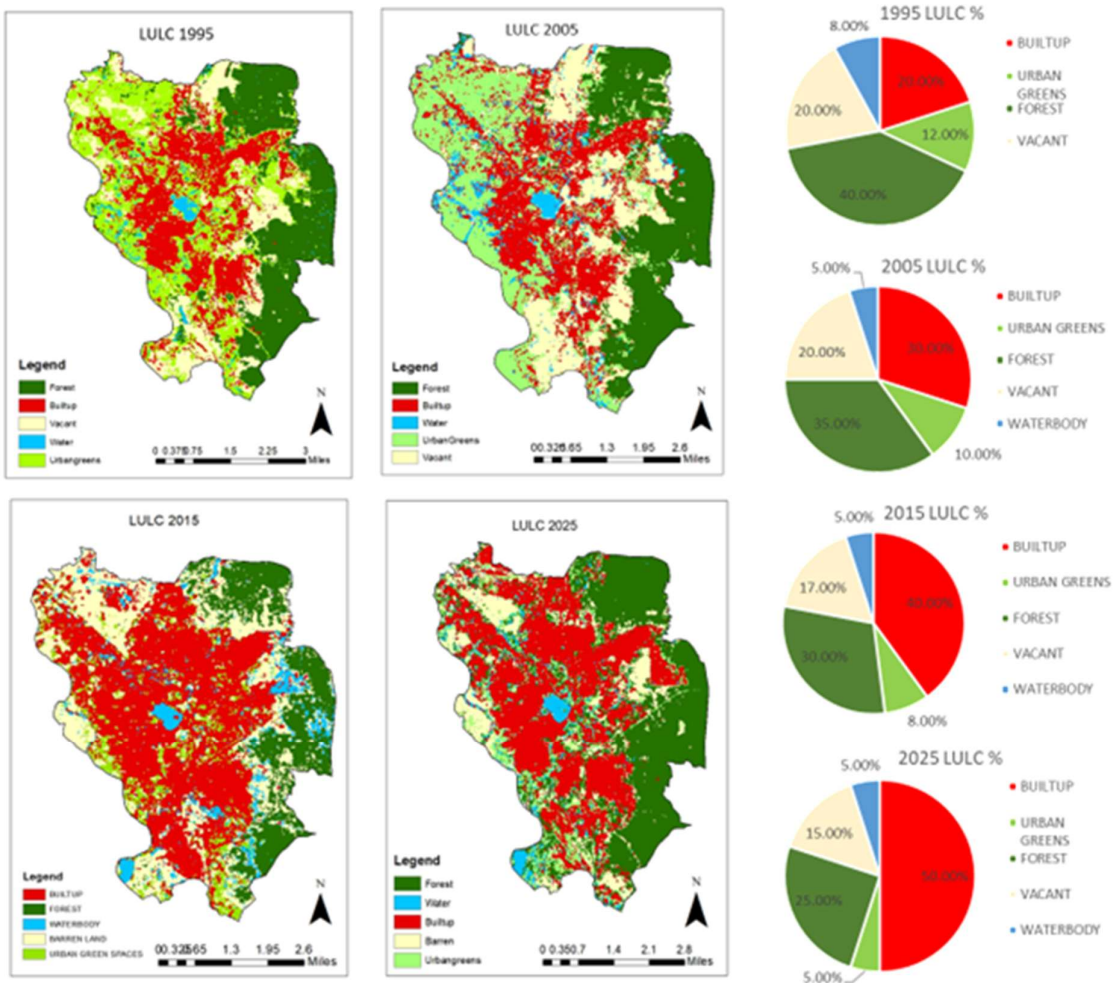


Figure 10: LULC MAP OF THE YEAR 1995, 2005, 2015 AND 2025 (Source: Author)

In 1995, the land is predominantly covered by forests and vacant land, with relatively smaller red patches indicating urban areas. By 2005, there's visible expansion of red areas (urban), showing early signs of urbanization and loss of green and vacant spaces. 2015 sees even more drastic red area expansion, with further shrinkage of forests and vacant lands. In the 2025, urban areas dominate the landscape, forests are fragmented, and urban greens and vacant lands are minimal.

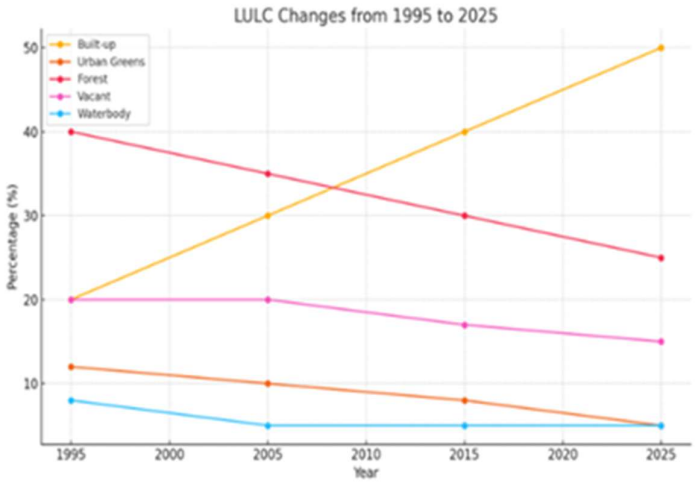


Figure 11:Line chart for LULC changes (Source: Author)

The line chart titled "LULC Changes from 1995 to 2025" illustrates the trends in Land Use and Land Cover over a 30-year period. It shows significant changes in the distribution of various land categories, including built-up areas, urban greens, forests, vacant land, and water bodies. The most notable trend is the steady increase in built-up areas, which have grown from 20% in 1995 to a projected 50% by 2025, indicating rapid urbanization and infrastructure development. In contrast, forest cover has seen a continuous decline from 40% to 25%, suggesting ongoing deforestation likely due to expanding urban areas. Urban green spaces have also diminished from around 13% to 6%, reflecting a reduction in natural areas within cities. Vacant land has slightly decreased from 20% to 16%, possibly due to being converted for development purposes. Similarly, water bodies have reduced from 8% to below 5%, pointing to environmental changes or land reclamation. Overall, the chart highlights the pressing impact of urban expansion on natural and undeveloped land, emphasizing the need for sustainable land use planning.

4.4 NDVI MAP

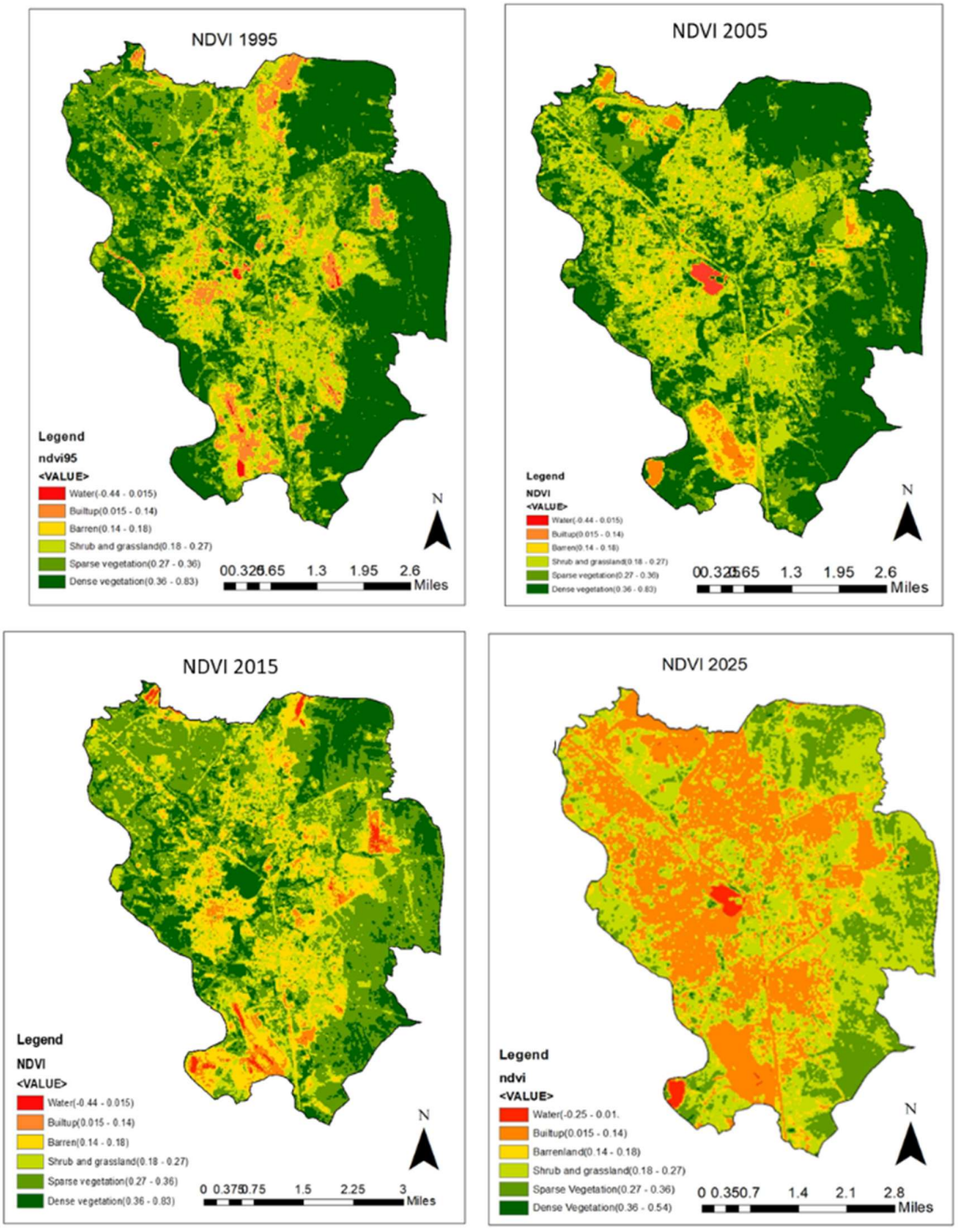


Figure 12: NDVI MAP OF THE YEAR 1995, 2005, 2015 AND 2025 (Source: Author)

NDVI 1995: The landscape is dominated by dark green, indicating extensive dense vegetation. This suggests a high level of plant cover and ecological health in the region. Urban (red) and barren areas (yellow/orange) are minimal.

NDVI 2005: Vegetation shows signs of early degradation, especially around urbanizing zones. Slight increases in orange and yellow patches suggest the start of conversion from green areas to grassland, shrubland, and barren zones. Built-up areas begin expanding (in red).

NDVI 2015: More noticeable loss of vegetation, with significant spread of yellow and orange areas. The built-up area continues to grow. Green zones (dense and sparse vegetation) are getting more fragmented and retreating from city centers and developing corridors.

NDVI 2025: The map projects a drastic decline in vegetation. Large areas are converted to shrubs, grasslands (orange), and built-up zones (red). Dense vegetation becomes limited, primarily found on the outskirts or protected areas. Urban sprawl clearly dominates the land.

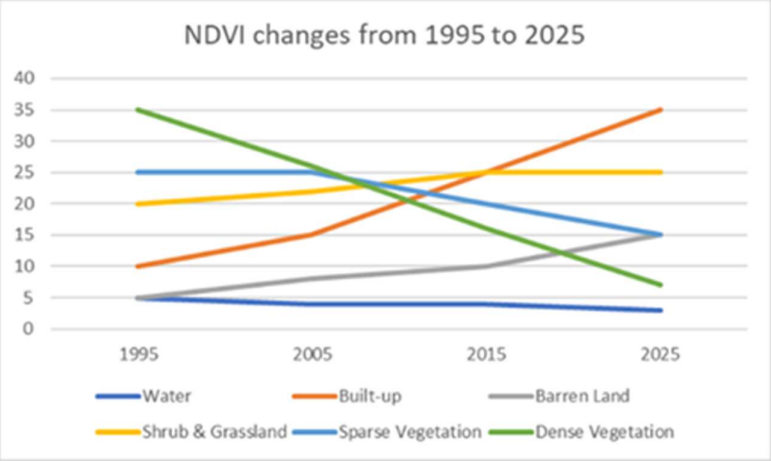


Figure 13: Line chart for NDVI changes (Source: Author)

The line chart titled "NDVI Changes from 1995 to 2025" presents the variation in different land cover types based on the Normalized Difference Vegetation Index (NDVI) over a 30-year period. NDVI is commonly used to assess vegetation health and density. The chart shows seven land cover categories: water, built-up areas, barren land, shrub & grassland, sparse vegetation, and dense vegetation. The chart highlights a clear trend of declining vegetation, particularly dense vegetation, alongside increasing built-up and barren lands. This indicates a growing ecological imbalance driven by human activity and emphasizes the need for conservation and sustainable land management strategies.

4.5 LST MAP

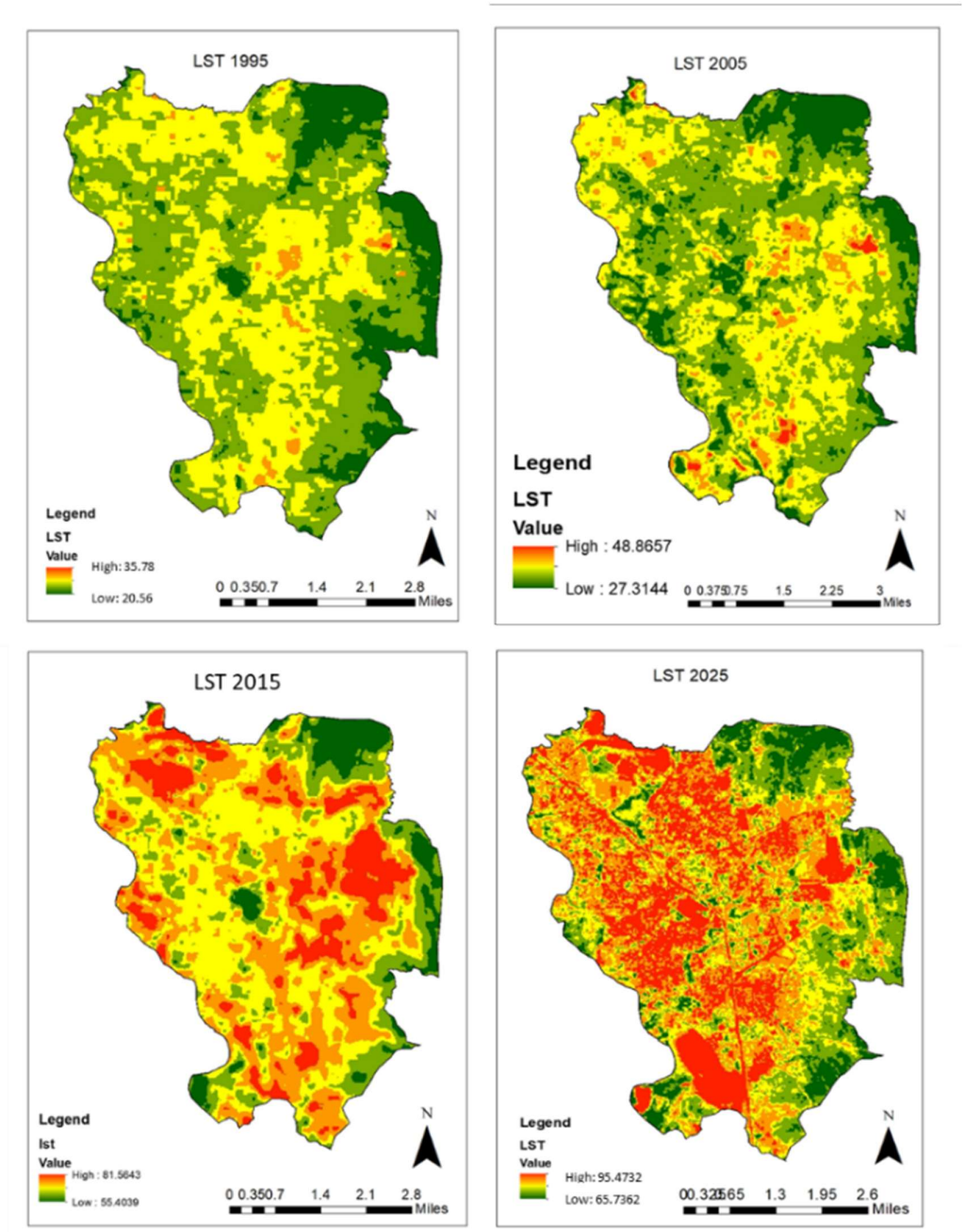


Figure 14: LST MAP OF THE YEAR 1995, 2005, 2015 AND 2025 (Source: Author)

The analysis of Land Surface Temperature (LST) maps from 1995 to 2025 reveals a clear and alarming trend of rising surface temperatures, primarily driven by urbanization, vegetation loss, and land-use changes. In 1995, the region exhibited predominantly low to moderate LST values, as indicated by the green and yellow zones, reflecting a healthy environment with significant vegetation cover. By 2005, a noticeable increase in temperature occurred, with a growing presence of yellow and red patches, suggesting ongoing vegetation degradation and

urban expansion. The 2015 map shows an even more pronounced rise in high-temperature zones, particularly in red, indicating the intensification of urban heat island (UHI) effects due to substantial urban growth and reduced greenery. The 2025 map highlights a severe escalation in surface temperatures, with widespread dominance of high-temperature red zones, reflecting critical UHI impacts and environmental stress. Supporting this visual analysis, the accompanying graph shows a consistent increase in both minimum and maximum LST values over the 30-year span. This rising temperature trend strongly correlates with the loss of vegetation and unchecked urban development, emphasizing the urgent need for sustainable urban planning, green infrastructure, and environmental conservation measures to mitigate the adverse effects of increasing LST.

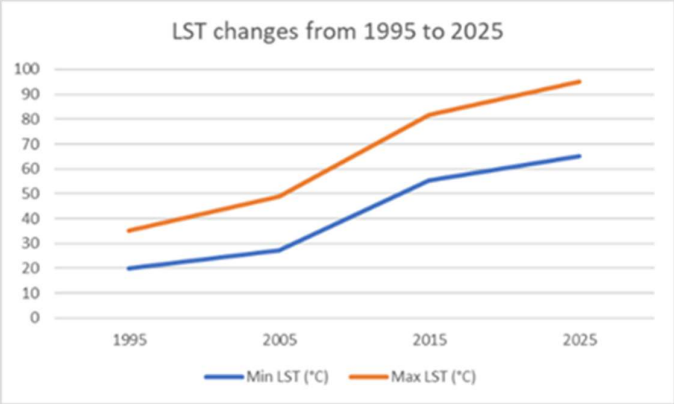


Figure 15: Line chart for LST changes (Source: Author)

The chart highlights a clear and concerning rise in land surface temperatures over the past three decades. The increase in both minimum and maximum LST values reflects the intensifying urban heat island effect and changing land use patterns. These findings underscore the need for climate-responsive urban planning, including strategies to preserve vegetation and reduce heat absorption in built-up areas.

4.6 SAVI MAP

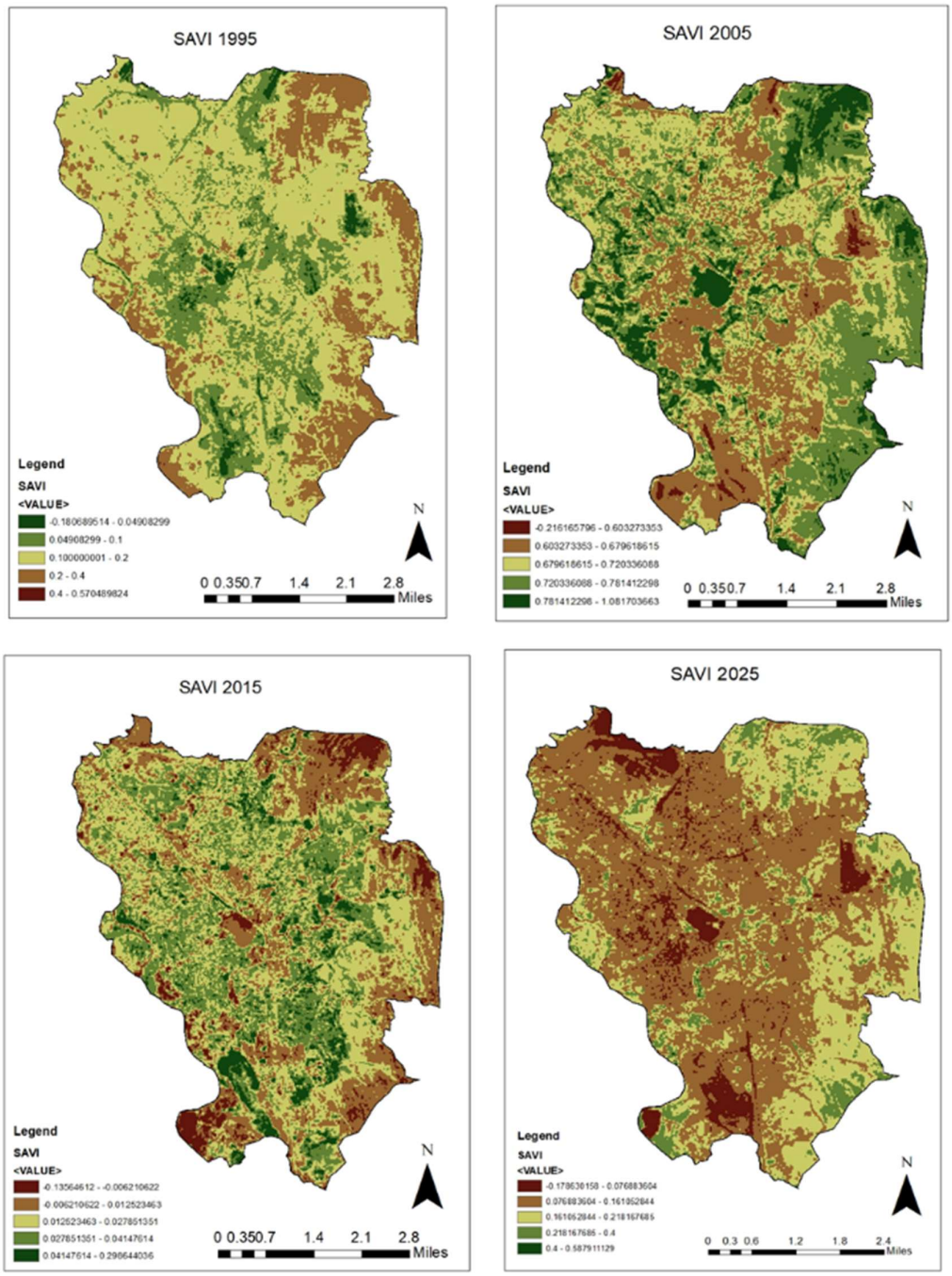


Figure 16: SAVI MAP OF THE YEAR 1995, 2005, 2015 AND 2025 (Source: Author)

The SAVI analysis for Chandrapur from 1995 to 2025 highlights significant changes in vegetation health and land condition over time. Between 1995 and 2005, the region experienced a positive shift in vegetation health, as reflected by an increase in SAVI values and a higher proportion of green zones on the map. This improvement suggests effective land use and

possibly conservation efforts during that period. However, this trend reversed post-2005, with continuous degradation in vegetation cover observed through 2015 and projected to worsen by 2025. The maps and SAVI graph clearly show a steady decline in mean SAVI values, indicating increasing vegetation stress and loss. By 2025, the majority of the region is expected to be covered by low SAVI values, signifying poor vegetation health. The supporting indicator table reflects this trend, showing a shift from high vegetation cover and good environmental health in 2005 to low vegetation cover, high land degradation, and dominant urban/non-vegetative land by 2025. These patterns underscore the environmental cost of rapid urbanization and land use change, highlighting the urgent need for sustainable development practices and conservation strategies to restore ecological balance and prevent further environmental decline.

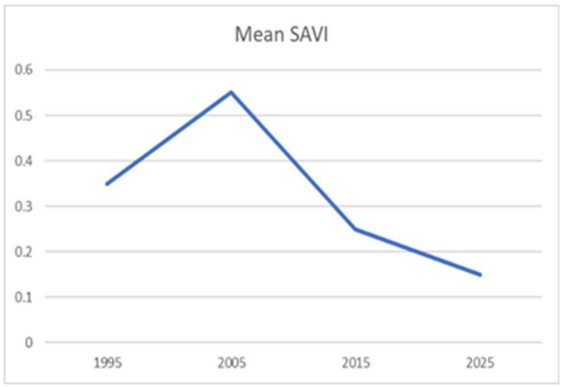


Figure 17: Line chart for SAVI changes (Source: Author)

The SAVI trend suggests that while vegetation cover improved during the early period, it has steadily deteriorated since 2005, likely due to urban expansion, deforestation, and land degradation. This decline in SAVI aligns with other environmental indicators and reinforces the need for sustainable land management and reforestation efforts.

4.7 SELECTION OF NEIGHBOURHOODS

Decadal analysis is done to identify and understand the trend in the Chandrapur city. The five study areas were selected based on land use and land cover (LULC) diversity, vegetation health (NDVI), surface temperature (LST), and urban transformation dynamics. Areas with high urban expansion and increasing built-up footprint are prioritized. These areas show various characteristics of green spaces and their availability.

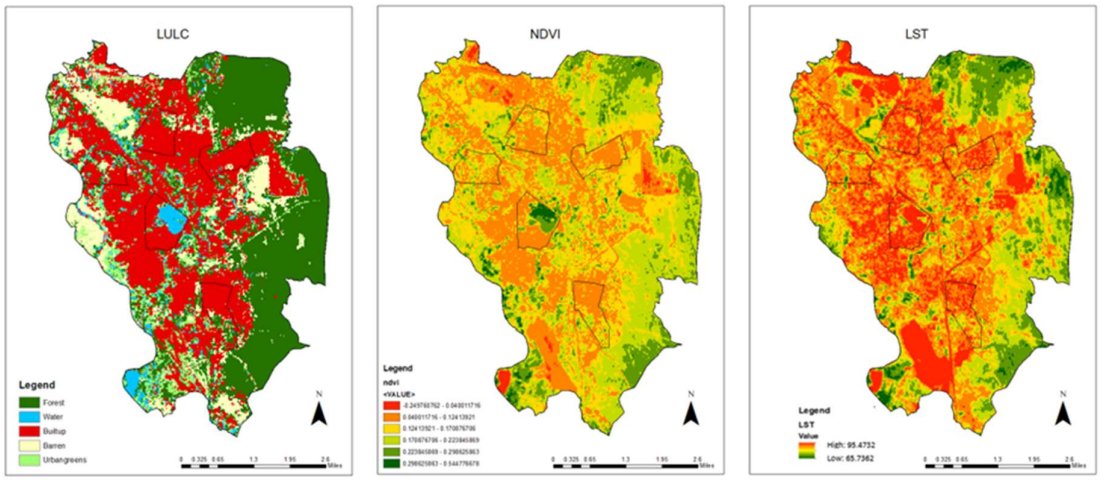


Figure 18: Selected study areas

4.8 STUDY AREAS

The study was further carried out for five neighbourhoods of different characteristics. These areas represent distinct land-use types, including dense forest, expanding urban centres, peri-urban transitional zones, barren or degraded lands, and water-influenced environments. Using high-resolution satellite data and GIS tools, the regions were analyzed for population density, land transformation rates over time, and proximity to urban infrastructure such as roads and administrative centres. This selection framework ensures each study area reflects a unique interaction between urbanization, environmental degradation, and thermal behaviour, enabling more nuanced insights into the spatial impacts of land-use change and supporting the development of targeted sustainability and conservation strategies. A set of ecological and spatial parameters were used to evaluate the environmental conditions of these neighborhoods:

a. Patch Area and Perimeter
b. Open Surface Percentage
c. Waterbody Coverage (%)
d. Greenspace Coverage (%)
e. Vegetation Cover (%)
f. Greenspace per Capita

4.8.1 STUDY AREA 1 – REVENUE COLONY

Revenue Colony is a locality in Chandrapur, a city in the Indian state of Maharashtra. It is situated near the city's central business district and is known for its residential and commercial

properties. The colony's proximity to the city's industrial areas and the Chandrapur Super Thermal Power Station also makes it an important hub for business and commerce. The area has 4 urban parks: Aaji Ajoba Park, Pandit Dindayal Upadhayay Garden, Kalpana Chawla Garden and Jagannath Baba Udyan.

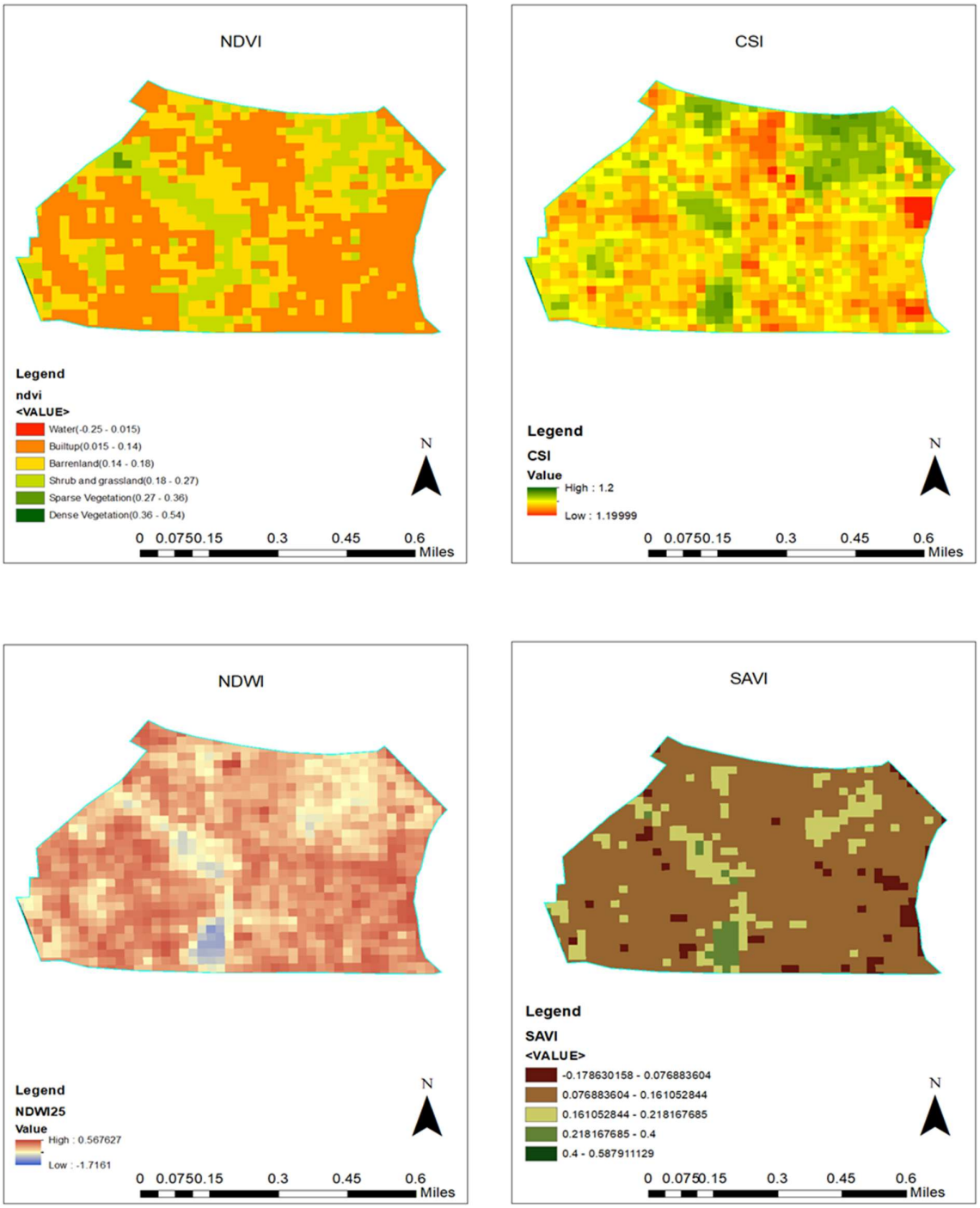


Figure 19: Revenue Colony maps; NDVI, CSI, NDWI, SAVI (Source: Author)

The Revenue Colony study area exhibits predominantly sparse vegetation, with healthier vegetation patches concentrated in the north-central and northwest zones. NDVI and SAVI analyses both indicate a dominance of exposed soil and built-up surfaces, confirming overall poor vegetation health. The Canopy Structure Index (CSI) suggests limited tree canopy coverage, though a few areas with denser patches align with higher NDVI and SAVI values. Additionally, NDWI results reflect overall dry surface conditions, reinforcing the lack of water retention and vegetation. The urban park coverage in this area is minimal, comprising only 0.55% of the total study area, while tree cover stands at 10.2%. Among the urban parks, only a few are developed, with Kalpana Chawla Garden and Pandit Dindayal Upadhayay Garden showing relatively higher patch areas and development levels.

4.8.2 STUDY AREA 2 – BAZAAR WARD AREA

Bazar Ward is a residential area located in Chandrapur city, Maharashtra, India. The area is known for its vibrant market, shops, and eateries. Bazar Ward is a popular hub for locals and visitors alike, offering a variety of goods and services. The area is also close to the Chandrapur Bus Stand and the Chandrapur Railway Station, making it a convenient location for commuting. The area has 2 urban parks: Ramala Garden and Maulana Abdul Kalam Azad Garden

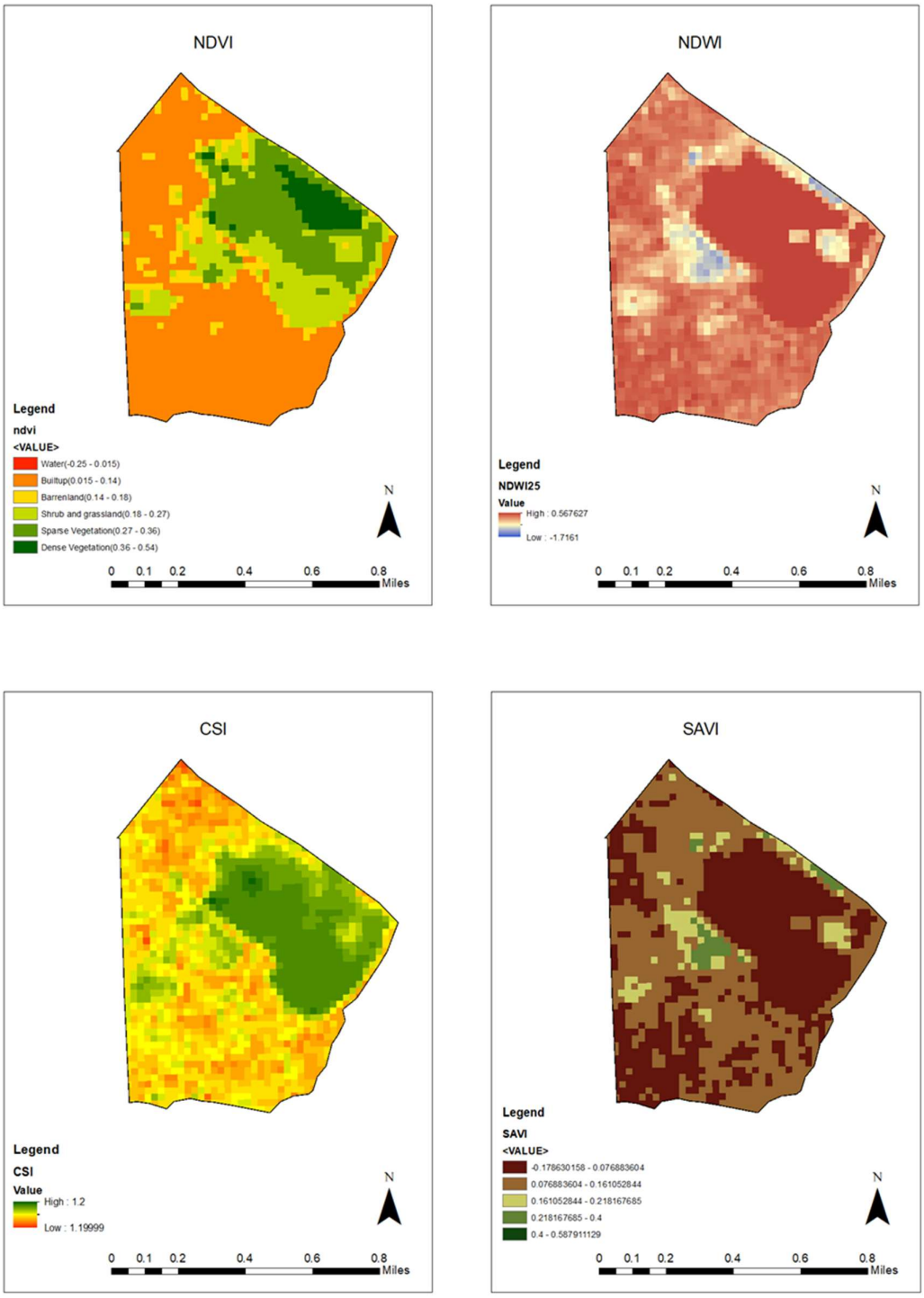


Figure 20: Bazaar ward maps; NDVI, CSI, NDWI, SAVI (Source: Author)

The Bazaar Ward Area shows a noticeable variation in vegetation health across its different zones. The northeastern part is consistently highlighted as having dense and healthy vegetation, while the central, southern, and western sections are primarily barren, built-up, and have sparse

vegetation. Vegetation indices such as NDVI, SAVI, and CSI exhibit strong correlation and confirm isolated patches of vegetation within largely non-vegetated surroundings. The NDWI analysis indicates overall dryness, although some central zones display slightly higher moisture levels. The total urban park area accounts for 43,664.43 sqm, representing 3.13% of the study area. Despite a high waterbody coverage of 27.52%, the tree cover remains relatively low at 4.81%.

4.8.3 STUDY AREA 3 – SHASTRI NAGAR

Shastri Nagar is a neighbourhood located in Tukum, Chandrapur district, Maharashtra, India. The area has only one urban park; i.e., Oxygen Park.

The Shastri Nagar study area is characterized by predominantly dry conditions and sparse vegetation, with minimal tree cover and negligible moisture presence. The landscape is largely built-up or consists of barren surfaces, offering limited ecological greenery. Analysis through indices such as the Canopy Shadow Index (CSI) and Soil Adjusted Vegetation Index (SAVI) reveals small vegetated pockets, particularly in the western and northwestern parts, likely consisting of trees or shrubs. Both NDVI and NDWI further confirm the low levels of vegetative and water presence across the region.

The total urban park area amounts to 30,536.73 sqm, which constitutes 2.87% of the total study area. There are no waterbodies present, and open surface area is minimal, covering only 1.46%. Tree cover accounts for 5.61% of the total area. Oxygen Park is the sole urban park in the region, developed with a patch perimeter of 695.55 meters.

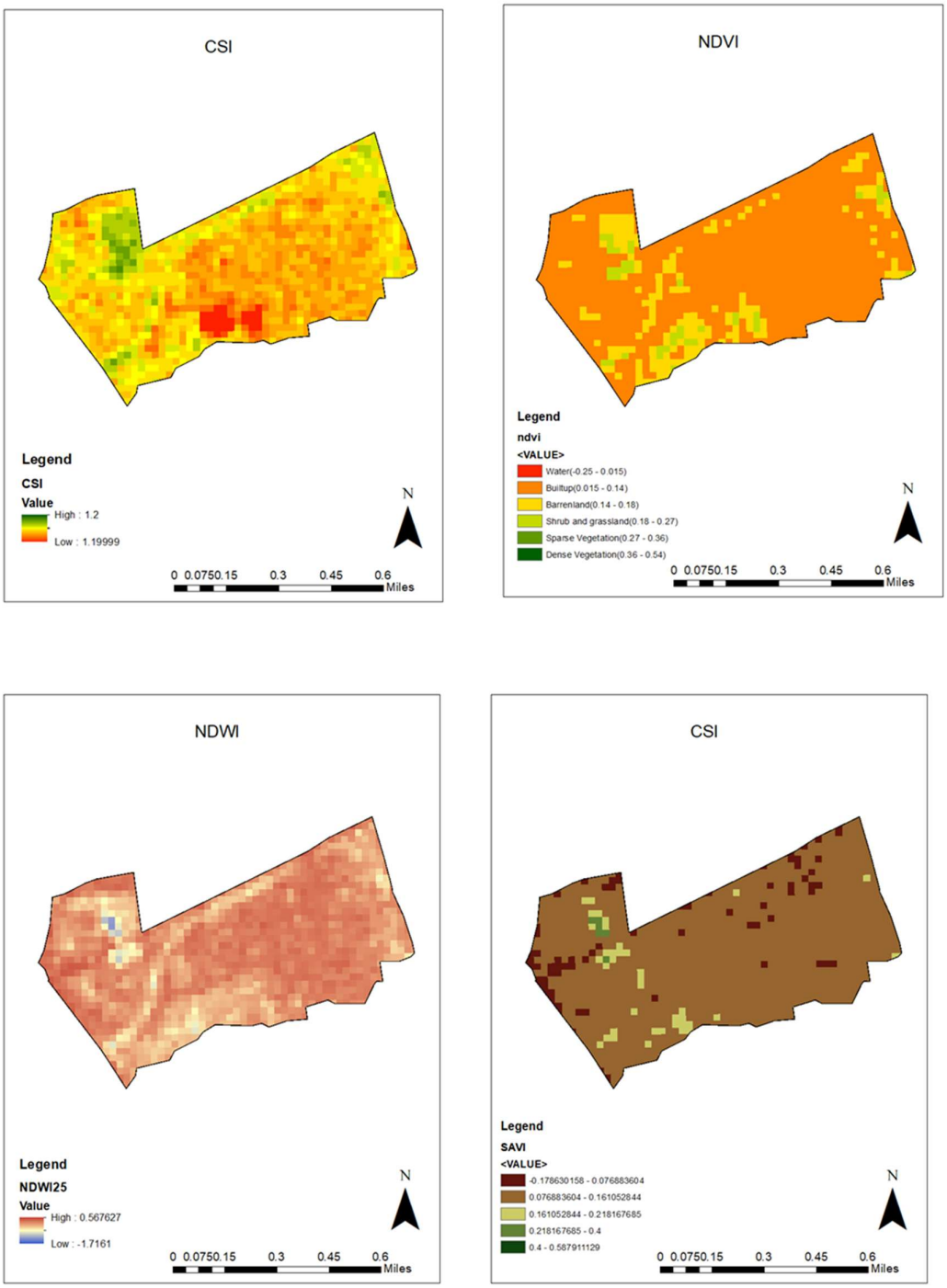


Figure 21:Shastri Nagar maps; NDVI, CSI, NDWI, SAVI (Source: Author)

4.8.4 STUDY AREA 4 – BABUPETH AREA

The area is situated near the Chandrapur Thermal Power Station and is surrounded by other residential colonies. The area is home to a mix of old and new buildings, with a blend of traditional and modern architecture. The area has 1 urban park: Maruti Garden

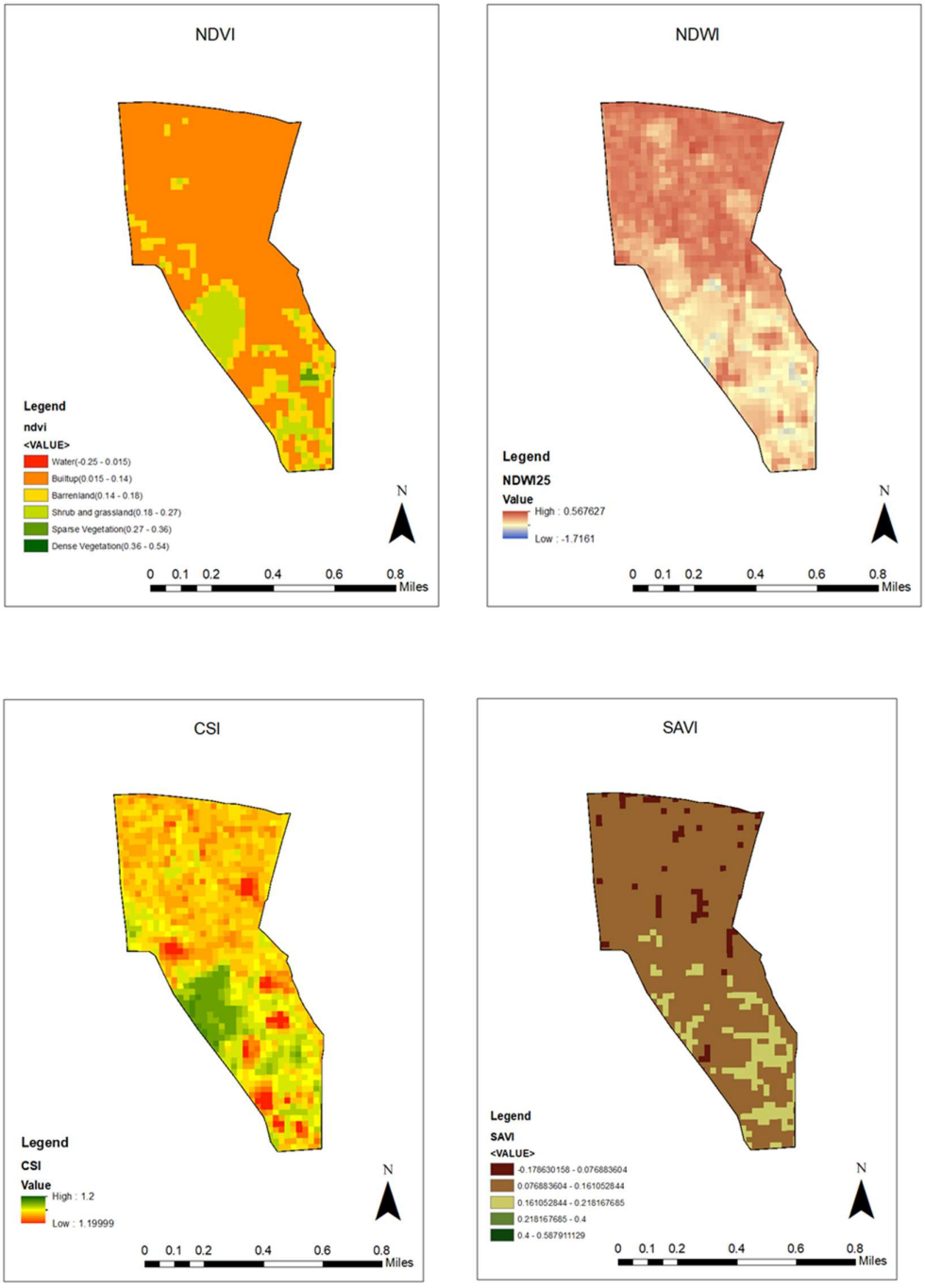


Figure 22: Babupeth Area maps; NDVI, CSI, NDWI, SAVI (Source: Author)

The Babupeth area exhibits limited vegetation health across most of its extent, particularly in the northern part, which is characterized by urbanization, barren land, and signs of vegetation degradation. The southern region, however, reflects relatively better ecological conditions, showing the presence of tree canopies, increased soil-adjusted vegetation, and moderate levels of water retention. Despite this, water scarcity is a notable concern throughout the study area, as the NDWI analysis indicates only a few moisture-retaining zones. The dominance of dry soil and lack of vegetative cover reinforce the semi-arid nature of the region. The total urban park area in Babupeth amounts to 8,230.86 sqm, representing 0.72% of the total study area. There are no waterbodies present, and open surface areas account for 4.93% of the landscape. The tree cover spans 140,501 sqm, making up 12.25% of the region. Maruti Garden is the only identified urban park in this area, currently not developed, with a patch perimeter of 353.01 meters.

4.8.5 STUDY AREA 5 – NIRMAN NAGAR

The locality Nirman Nagar, a residential area falls in Chandrapur district situated in Maharashtra state. Nirman Nagar is home to several apartments, housing societies, and commercial establishments, making it a popular residential option for families and working professionals. The area has 3 urban parks: ABC Park, Gurukunj Udyan and Shri Swami Samarth Shivneri (Baludyan).

The Nirman Nagar area exhibits low vegetation health and density, as indicated by the low NDVI and SAVI values. The region also shows limited water availability, with low NDWI values pointing to reduced soil moisture, which negatively affects plant growth. The sparse canopy coverage suggests minimal tree presence, with existing vegetation primarily consisting of smaller shrubs or grasses. The total urban park area in Nirman Nagar is 5,113.02 sqm, accounting for only 0.41% of the study area. There are no waterbodies present, and the open surface area constitutes 0.99% of the total. Tree cover is relatively low, at 27,476.52 sqm, representing just 2.21% of the area. The parks in this locality include ABC Park, Gurukunj Udyan, and Shri Swami Samarth Shivneri (Baludyan), with only two of the three developed. Greenspace per capita stands at 2.01 square meters per person, indicating limited access to urban greenery for residents.

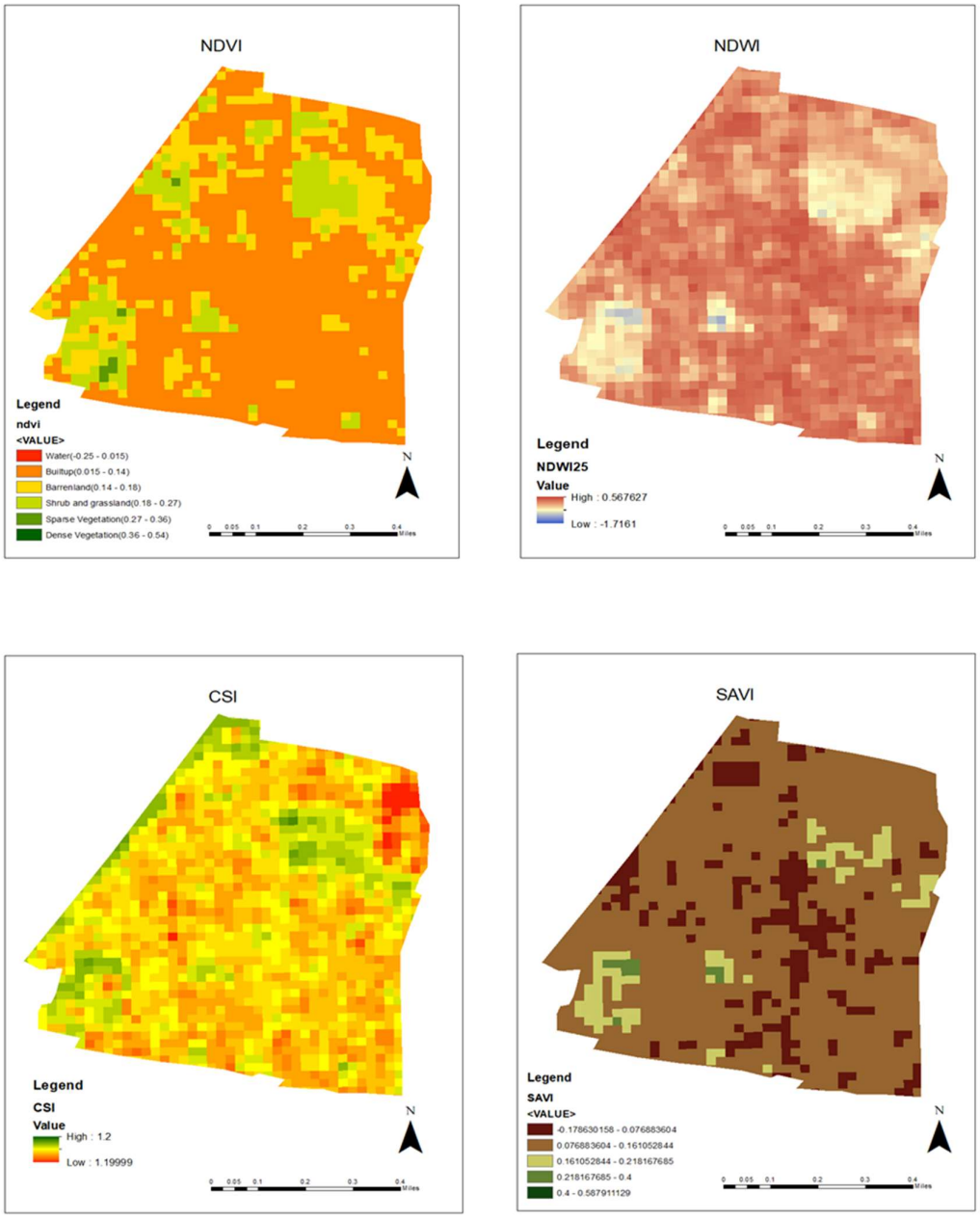


Figure 23: Nirman Nagar maps; NDVI, CSI, NDWI, SAVI (Source: Author)

4.7 INFERENCES

Table 4: Comparative Chart of the selected study areas (Source: Author)

Parameter	Revenue Colony	Bazaar Ward Area	Shastri Nagar	Babupeth	Nirman Nagar
Population	10,844	13,324	10,423	11,205	11675
Urban Parks	4 (Aaji Ajoba Park, Pandit Dindayal Upadhayay Garden, Kalpana Chawla Garden, Jagannath Baba Udyan)	2 (Ramala Garden, Azad Garden)	1 (Oxygen Park)	1 (Maruti Garden)	3 (ABC Park, Gurukunj Udyan, Shri Swami Samarth Shivneri)
Green Space per Capita	8.2	4.3	5.8	10.6	2.01
Patch Area (sqm)	1,039,117.21	1,393,447.33	1,063,844.49	1,146,564.04	1,241,729.34
Tree Cover Area (sqm)	106038.48	67054.31	59728.48	140501	27476.52
Tree Cover %	10.2%	4.81%	5.61%	12.25%	2.21
Vegetation Quality	Sparse, scattered	Dense northeast, sparse elsewhere	Dry, patchy vegetation	Better in south, degraded in north	Low Vegetation Health
Environmental Condition	Limited canopy, dry	Mixed with water traces	Very dry and built-up	Moderate, but semi-arid north	Low to moderate canopy coverage,
NDVI/SAVI Trend	0.223719	0.2915755	0.2023445	0.2286785	0.267098
NDWI (Water Index)	-0.358787	0.278309	-0.51356	-0.4396485	-0.494494

4.8 SUMMARY

Multi-temporal satellite imagery and field data are analyzed to evaluate changes in vegetation, temperature, and land use. The five selected neighborhoods—Revenue Colony, Bazaar Ward Area, Shastri Nagar, Babupeth, and Nirman Nagar—are assessed for ecological and urban parameters. The results show a trend of increasing urbanization, loss of green cover, and rising temperatures, with uneven distribution of green space across areas.

CHAPTER 5: OBSERVATIONS AND RESULTS

CHAPTER 5: OBSERVATION AND RESULTS

5.1 INTORDUCTION

This chapter presents the results from geospatial analysis and survey data, correlating green space availability with various quality of life indicators across neighborhoods.

5.2 RESULTS

Urban green spaces play a critical role in enhancing the quality of life (QoL) of residents by contributing to environmental sustainability, physical and mental well-being, and social cohesion. In this study, a structured questionnaire survey was conducted across the five neighbourhoods in Chandrapur — Revenue Colony, Bazaar Ward Area, Shastri Nagar, Babupeth, and Nirman Nagar — to assess residents' perceived quality of life through various indicators. The survey was based on a Likert scale scoring system (ranging from 1 to 5), with 1 indicating poor or unsatisfactory conditions and 5 indicating excellent conditions.

Table 5: Analysis of indicators on 5-point Likert Scale

INDICATOR	Revenue Colony	Bazaar Ward Area	Shastri Nagar	Babupeth	Nirman Nagar
1. SAFETY	5	2	1	4	3
2. ACCESSIBILITY	4	5	3	1	2
3. NUMBER OF URBAN PARKS	5	3	2	1	4
4. EMOTIONAL HEALTH	3	1	2	4	5
5. SOCIAL RELATIONS	5	2	3	1	4
6. PHYSICAL HEALTH	4	5	1	3	2
7. OPEN SURFACE	4	1	3	5	2
8. TOTAL VEGETATION COVER	4	2	3	5	1
9. WATERBODY	4	5	1	1	1
10. GREENSPACE PER CAPITA	4	2	3	5	1
AVERAGE	4.1	2.8	2.2	3.0	2.5

1	2	3	4	5

The matrix reveals a direct correlation between green infrastructure indicators (urban parks, greenspace per capita, tree cover) and residents' perceptions of health, emotional well-being, and safety. Neighbourhoods with higher green space availability also reported higher emotional

and physical health satisfaction, suggesting a positive relationship between environmental quality and QoL.

Furthermore, the data suggests that areas with better planned public spaces and vegetation show better social cohesion and safety perceptions. This aligns with urban planning theories advocating that well-maintained and accessible green spaces improve urban liveability.

This matrix identifies three critical urban areas; Shastri Nagar, Nirman Nagar, and Bazaar Ward Area that exhibit low performance in multiple indicators, and will be selected to propose targeted interventions to address these deficiencies.

5.2.1 Shastri Nagar Problem

Shastri Nagar exhibits the lowest average quality of life score (2.2) among all study areas, with critical issues in safety (1), physical health (1), emotional health (2), and vegetation cover (3). The lack of urban parks (score 2) and green infrastructure is directly affecting physical activity levels, community interaction, and emotional well-being.

5.2.2 Nirman Nagar Problem

Nirman Nagar has a below-average quality of life score of 2.5, with critical deficits in waterbody presence (1), greenspace per capita (1), open surface (2), and vegetation cover (1). Despite having three urban parks, only two are developed, and the total urban park area constitutes just 0.41% of the neighbourhood. The NDVI, NDWI, and SAVI data further confirm poor vegetation health.

5.2.3 Bazaar Ward Area Problem

Bazaar Ward Area has an average score of 2.8, with particularly low performance in emotional health (1), social relations (2), open surface (1), and number of urban parks (3). Being a high-density zone with good accessibility (score 5), the lack of recreational and interaction spaces contributes to social fragmentation and mental stress.

5.3 SUMMARY

Neighborhoods with greater green infrastructure show better outcomes in health, safety, and emotional well-being. Revenue Colony performed best, while Shastri Nagar and Bazaar Ward scored poorly. The findings validate the hypothesis that access to well-maintained green spaces improves urban residents' quality of life.

CHAPTER 6: PROPOSALS AND RECOMMENDATIONS

CHAPTER 6: PROPOSALS AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter proposes strategies for enhancing urban green spaces in Chandrapur based on the study findings, aiming to improve quality of life and promote sustainable urban development.

6.2 PROPOSALS

6.2.1 GREEN CORRIDOR FOR THE NEIGHBOURHOODS

This proposal outlines a strategic plan to develop green corridors across five key urban zones in Chandrapur City. The project aims to improve air quality, reduce urban heat, enhance biodiversity, and promote healthier lifestyles through tree-lined streets and shaded pedestrian paths.

Table 6: Native Tree species of Chandrapur (33% GREEN COVER DEVELOP ACTION PLAN-MAZI VASUNDHARA 2.0, 2021-2022)

Sr. No.	Botanical Name	Common Name
1	Acacia catechu	Khair
2	Aegle marmelos	Bel
3	Balanties aegyptiaca	Hingan, Ingudi
4	Butea monosperma	Palash
5	Cassia fistula	Indian Labernum
6	Dalbergia	Shisham
7	Mangifera Indica (Country variety)	Mango
8	Mimusopselengi	Bakul
9	Oroxylon indicum	Tetu
10	Pongamia pinnata	Karanj
11	Pterocarpus santalinus	Rakta Chandan
12	Santalum album	Chandan
13	Saraca asoca	Sita Ashok
14	Semecarpus anacardium	Biba
15	Syzygium cumini	Jamun
16	Tecomella undulata	Marwar Teak, Rohitak
17	Terminalia arjuna	Arjun
18	Terminalia belerica	Behada
19	Azadirachta indica	Kaduneem
20	Albizia lebbeck	Shirish
21	Ficus benghalensis	Vad
22	Ficus religiosa	Pimpal

Objectives of green corridor is to Create shaded, continuous walkable spaces across urban areas, Combat air pollution and reduce surface temperatures, Support biodiversity through native tree plantation, Promote community involvement in urban greening.

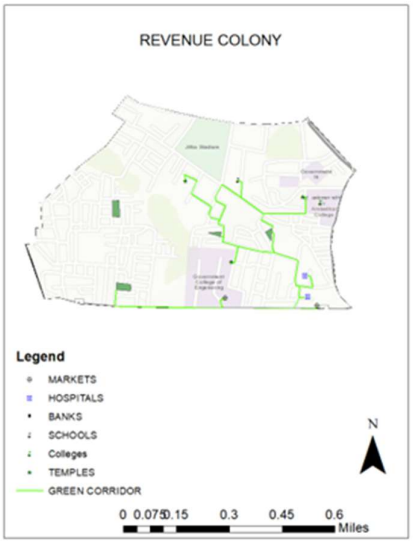


Figure 24: REVENUE COLONY GREEN *CORRIDOR*

Corridor Length = 5995 m

Figure 25: BAZAAR WARD GREEN CORRIDOR

Corridor Length = 3413m

Figure 26:SHASTRI NAGAR GREEN CORRIDOR

Corridor Length = 4593m

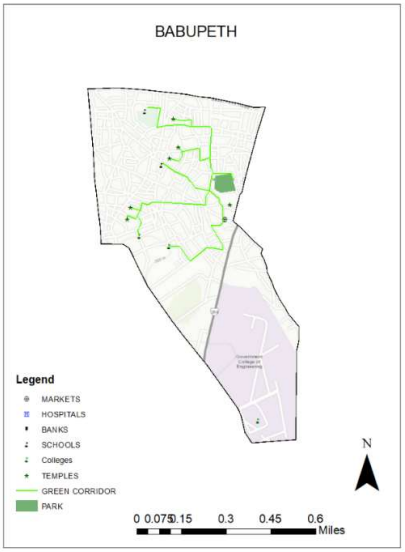


Figure 27:BABUPETH GREEN CORRIDOR

Corridor Length = 3183m

Figure 28:NIRMAN NAGAR GREEN CORRIDOR

Corridor Length = 3710 m

The proposal involves connecting the public amenities to the urban parks through green corridor. Hence, markets, schools, colleges, banks, hospitals and temples have been marked. These public amenities are then connected via shortest routes to existing urban parks in order to create safe, accessible and shaded path for the people. This intervention will ensure increase in green cover in the neighbourhoods also leading to community participation.

Trees which have beautiful flowering tree, are drought-resistant, excellent air purifier, fast-growing, shade provider, tolerates pollution, have deep roots are recommended for the plantation of trees for the tree corridor across the neighbourhood. Mostly native species will be preferred for this purpose which includes Vad, Jamun, Pimpal, Ashok, Chandan etc.

6.2.2 Public-Private Partnership (PPP) Model for Urban Park Maintenance in Chandrapur

The model proposes leveraging private sector participation for the upkeep and development of public parks in Chandrapur while simultaneously providing commercial opportunities for the private partner. This initiative seeks to enhance urban green infrastructure, promote civic engagement, and generate employment, all at minimal public cost.

Urban parks in Chandrapur face challenges such as Inconsistent maintenance, Lack of modern amenities, Limited civic engagement, Budget constraints within the municipal system. Drawing from the Ahmedabad example, this PPP model proposes a win-win solution where the private partner maintains parks in exchange for space to operate branded retail kiosks, like dairy parlours or cafés.

Objectives of this model are to ensure sustainable and professional maintenance of public parks, improve infrastructure and cleanliness in urban green spaces, foster public-private cooperation for civic benefit, create employment and community participation.

Working of the model:

Chandrapur Municipal Corporation allots space within select public parks for retail kiosks.

The private partner develops and maintains the park infrastructure (landscaping, cleanliness, security, sanitation). Retail operations within the park help offset maintenance costs for the private partner.

NGO/trust acts as a third-party overseer ensuring quality and transparency.

Strategic use of Parks includes allowing the partner company to set up branded retail outlets (e.g., dairy booths, cafés, kiosks) within designated public parks and ensure these outlets are aesthetically designed to blend with the park's environment.

Stakeholder	Role
CMC	Provides land, regulatory approvals, and oversight
Private Partner (e.g., Amul or equivalent)	Maintains parks; installs and runs kiosks
NGO Partner / Trust	Monitors implementation, community association

Adopting this PPP model in Chandrapur will revitalize public parks, foster civic pride, and enable resource-efficient urban development.

6.2.3 Proposal for Bazaar Ward: Ecological Restoration Proposal for Bazaar Ward Lake

The lake situated in Bazaar Ward is experiencing significant ecological stress due to eutrophication, primarily caused by nutrient-rich runoff and untreated sewage inflow. These conditions have led to poor water quality, reduced biodiversity, and a compromised aquatic ecosystem. There is an urgent need for an affordable, sustainable, and nature-based solution that can be effectively integrated within the existing landscape and urban fabric.

Proposed Interventions:

1. Floating Wetlands

Implement modular floating wetland rafts planted with a diverse range of aquatic vegetation. These systems are designed to Absorb excess nutrients (nitrates, phosphates) and organic pollutants, uptake heavy metals (e.g., lead, arsenic) from the water column, mimic the purification functions of natural wetlands, particularly in zones where shoreline restoration is not feasible.

Mechanism:

Aquatic plants are rooted in floating platforms with their roots hanging freely into the water. The submerged root systems act as biofilters, removing pollutants and providing habitat for microbial communities that further aid in pollutant breakdown.

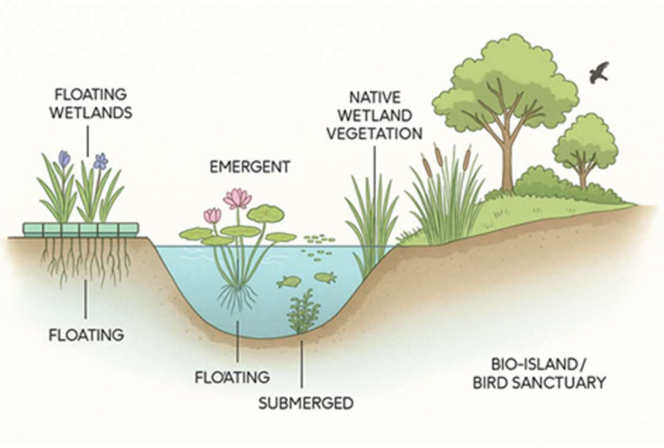


Figure 29:Schematic Diagram

2. Peripheral Green Buffer Zone

Develop a 30 m wide greenbelt around the periphery of the lake using native flora to serve as a bio-buffer. This zone will prevent urban encroachment and maintain ecological integrity, act as a transition zone between urban and aquatic ecosystems.

Figure 30: BAZAAR WARD PERIPHERAL GREEN BUFFER ZONE

3. Rain Gardens and Bioswales

Integrate rain gardens and bioswales into the peripheral zone to manage stormwater runoff. These features will naturally filter stormwater, reducing nutrient and pollutant load entering the lake, enhance groundwater recharge and improve local microclimate.

Specific plant species will be chosen based on their ability to absorb, degrade, or immobilize various pollutants:

Nutrient Absorption: Species effective in nitrate and phosphate uptake

Heavy Metal Tolerance: Species that can accumulate or degrade lead, arsenic, etc.

Organic Pollutant Breakdown: Species that support microbial degradation of complex organics

Expected Outcomes: Improved water quality and aesthetic value of the lake, increased biodiversity, creating habitat for birds and aquatic organisms, strengthened resilience against pollution and climate variability, enhanced community engagement through visible environmental improvement.

Implementation and Monitoring: A phased implementation strategy will be employed, starting with pilot installations at high-impact zones. Regular monitoring of water quality, plant health, and pollutant levels will be conducted to measure effectiveness and guide future scaling.

6.2.4 Pocket Park Proposal for Shastri Nagar

Shastri Nagar, a densely populated residential neighbourhood in Nagpur, faces a critical shortage of accessible green open spaces. The lack of recreational and ecological amenities adversely affects the physical and mental well-being of the residents, particularly children and the elderly. In response, a network of pocket parks is proposed to revitalize underutilized plots and improve the quality of urban life.

Objectives of this proposal are to transform vacant plots into vibrant, accessible green spaces, provide residents with venues for recreation, relaxation, and social interaction, enhance neighbourhood liveability through ecological and aesthetic upgrades, promote inclusive urban development with community engagement and participation.

Based on the spatial analysis of Shastri Nagar, four key vacant plots have been identified for potential development into pocket parks. Key Selection Criteria includes availability of publicly utility land, proximity to residential clusters, existing lack of greenery and recreational facilities, potential for safe pedestrian access.

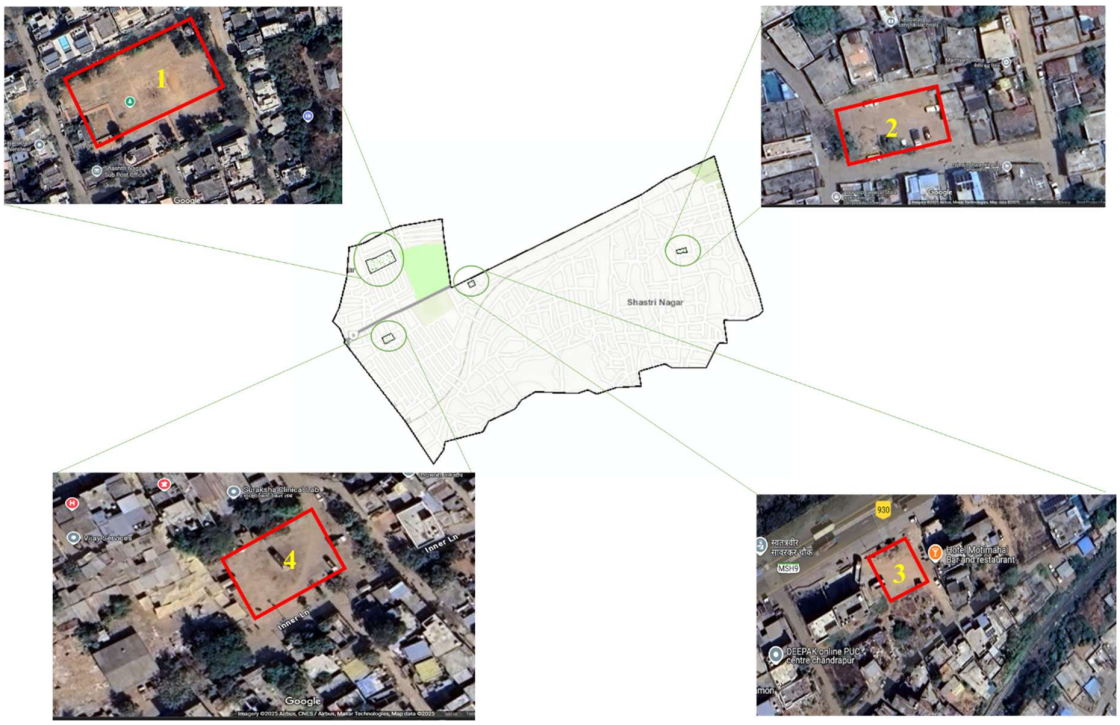


Figure 31: Pocket parks location

Four strategically identified locations within Shastri Nagar have been proposed for the development of pocket parks, utilizing available PU (Public Utility) land to enhance green cover and community spaces. Park 1, with an approximate area of 5241.55 sq.m, is located adjacent to the Krishna Temple and lies in close proximity to the existing Oxygen Park, making it ideal for extending recreational and ecological functions. Park 2, measuring around 603.93 sq.m, is situated within a densely clustered residential area, offering a much-needed open space for residents. Park 3, covering 453.76 sq. m, is positioned near a local school and along MSH-7, providing both educational and commuter advantages. Park 4, with an area of 1087.68 sq.m, is located next to the bustling Bhaji Market, where high pedestrian activity underscores the need for shaded, accessible rest and green areas. These sites collectively aim to provide inclusive, accessible, and ecologically beneficial green spaces within the urban fabric of Shastri Nagar.

Each location is mapped and marked with a red boundary and a numeric label for identification. The distribution ensures equitable green space access across different sections of Shastri Nagar.

Site-Specific Recommendations:

Park 1 (5243.54 sq.m): Ideal for a multi-functional recreational park; Include open lawns for sports, an amphitheatre for cultural activities, and meditation zones; Integration with nearby temple and park for a larger green network

Park 2 (603.91 sq.m): Best suited for a quiet neighbourhood garden; Emphasis on compact sitting spaces, vertical greenery, and ornamental plants; Can serve as a cooling node in a dense residential zone

Park 3 (457.56 sq.m): Proximity to a school allows for an educational eco-park; Install interactive educational boards on plants, recycling, and biodiversity; Fencing is essential for child safety due to road proximity

Park 4 (1087.63 sq.m): Located in a commercially active area, suited for a community plaza with green buffers; Include shaded waiting areas, benches, and native tree plantations; Focus on maintaining unobstructed pedestrian movement

Community Involvement: The project encourages active resident participation at each stage; Initial design workshops with local stakeholders, community-driven plantation drives, park stewardship committees for long-term maintenance.

6.2.5 Recommendations for Environmental and Recreational Improvements in Nirman Nagar

Based on the spatial and environmental analysis of Nirman Nagar, the following strategic recommendations are proposed to address key ecological and social deficiencies:

Establishment of a Green Buffer Zone Adjacent to the Thermal Power Plant

It is recommended that a 30 m wide green buffer be developed along the western boundary of Nirman Nagar, which borders the thermal power plant. This vegetative buffer should consist of dense, multi-layered plantations including native tree and shrub species such as Neem, Peepal, and Ashoka, known for their air-purifying and pollutant-trapping capacities. The buffer will serve as an ecological barrier to reduce air and noise pollution from the adjoining industrial zone. To maximize environmental benefit, the green strip should include deep-rooted tree

species capable of forming an effective windbreak. Additionally, this zone should be designed to accommodate walking tracks and passive recreational features, encouraging community interaction and health. The installation of air quality monitoring sensors is also recommended to assess improvements over time. Regular maintenance and active participation of local community groups or urban forestry agencies should be integrated into the long-term management strategy.

Revitalization of Leftover Recreational Spaces

It is further recommended that the numerous underutilized plots across Nirman Nagar, originally designated for recreation, be rehabilitated. These plots, currently functioning as informal dumping grounds or neglected open spaces, pose both environmental hazards and social safety concerns. Interventions should include proper fencing, landscaping, and the development of accessible recreational amenities to restore these areas to their intended use. Ensuring safety, accessibility, and aesthetic improvements will not only enhance the urban environment but also contribute positively to the mental and social well-being of local residents.

Development of multifunctional public spaces including:

- Children's play areas
- Outdoor gym equipment
- Shaded seating and pedestrian walkways

Inclusion of solar-powered lighting and sustainable drainage systems, involvement of local residents, and NGOs in the maintenance through various programs.

6.3 SUMMARY

The proposals represent a comprehensive, multi-dimensional strategy to improve urban quality of life through green infrastructure, addressing issues of environmental degradation, poor public space quality, limited recreational amenities, and low community engagement.

CHAPTER 7:
CONCLUSIONS

CHAPTER 7: CONCLUSIONS

This study clearly establishes that urban green spaces significantly contribute to improving the quality of life in Chandrapur city. Through a combination of geospatial analysis and primary survey data, it has been demonstrated that green infrastructure positively influences several critical dimensions of urban well-being, including emotional health, physical activity, safety, and social cohesion.

Neighbourhoods such as Revenue Colony, with better spatial planning, higher per capita green space, and greater tree cover, consistently scored higher across quality of life indicators. Residents in these areas reported feeling safer, more emotionally balanced, and physically healthier, with more opportunities for recreation and community interaction.

In contrast, localities like Shastri Nagar, Nirman Nagar, and Bazaar Ward Area, which have limited and poorly maintained green spaces, showed lower satisfaction levels and were marked by issues like higher surface temperatures, reduced vegetation health, and lower perceived safety.

Geospatial indices such as NDVI, SAVI, LST, and NDWI revealed the spatial inequities in vegetation cover and environmental health across different urban zones. Over the past three decades, rapid urbanization has led to a decline in vegetation cover and a corresponding increase in land surface temperatures, particularly in areas with inadequate green infrastructure. However, the presence of even small, strategically placed green spaces showed a noticeable moderating effect on environmental stressors, especially in densely built-up areas.

The study underscores that the role of urban green spaces extends beyond aesthetics; they serve as essential ecological and social infrastructure. Green spaces act as buffers against pollution and heat, offer venues for physical activity and relaxation, and foster social connectivity in otherwise fragmented urban environments.

Given Chandrapur's status as a rapidly urbanizing industrial city with high pollution levels, the integration of green spaces is not just desirable but essential. This research advocates for a multi-pronged approach that includes developing green corridors, restoring ecological assets like urban lakes, and creating neighbourhood-scale pocket parks, especially in under-served areas.

Ultimately, the evidence from this study confirms that sustainable urban planning centred around equitable access to green spaces can enhance the quality of life, reduce urban stress, and contribute to building healthier, more resilient communities. Urban green infrastructure must be prioritized in city planning policies to ensure inclusive and long-term well-being for all residents.

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ANNEXURE: Questionnaire

Name*

Your answer

Age

Your answer

Height (cm)

Your answer

Weight (kg)

Your answer

1. How often do you engage in physical activity ?*

- Daily
- 3-5 times a week
- 1-2 times a week
- Rarely
- Never

2. What type of physical activity do you frequently engage in?

- Strength Training
- Cardiovascular
- Flexibility exercise
- Sports
- Other:

3. On average, how long is each session?

- Less than 30 mins
- 30 - 60 mins
- Over 60 mins
- Other:

4. How do you rate your current physical health?*

Excellent

- 1
- 2
- 3
- 4
- 5

Poor

5. Do you feel that your fitness routine contributes to improved mental health?*

- Strongly Agree
- Agree

- Disagree
- Strongly disagree

6. How satisfied are you with the balance between fitness and other areas of your life (e.g., work, family, hobbies)?*

- Very satisfied
- Somewhat satisfied
- Neutral
- Somewhat dissatisfied
- Dissatisfied

7. To what extent do you believe fitness contributes to your quality of life?*

Significantly

- 1
- 2
- 3
- 4
- 5

Not at all

8. In what areas of life do you feel fitness has had the greatest impact?*

- Physical health
- Mental health
- Social interactions
- Other:

9. Do you have access to any green spaces in your neighborhood?*

- Yes
- No

10. If yes, how far is the nearest green space in your neighborhood?

- Within 500 m
- 500 m to 1 km
- More than 1 km

11. How often do you visit green spaces in your neighborhood?*

- Daily
- Weekly
- Monthly
- Rarely
- Never

12. What activities do you engage in when visiting green spaces?*

- Walking, jogging or exercise
- Relaxing or meditating
- Socializing
- Other:

13. How much time do you spend in green spaces during a visit

- Less than 30 mins

- 30 - 60 mins
- More than 1 hour

14. Do you feel safe and comfortable in green spaces you visit?*

- Yes
- No
- Maybe

15. How would you describe your overall mood after spending time in green spaces*

- Much better
- Somewhat better
- No noticeable change
- Somewhat bad
- Worse

16. Do you feel calm and relaxed while being in parks or gardens?

- Yes
- No

17. Do you feel a connection to nature when spending time in green spaces*

Strongly agree

- 1
- 2
- 3
- 4
- 5

Strongly disagree

18. Do you believe green spaces improve your mental health*

- Yes
- No
- Maybe

19. How do you rate your stress levels after visiting a green space*

Very low

- 1
- 2
- 3
- 4
- 5

Very high

20. What are the major challenges you face regarding the use of green space?*

- Poor Accessibility
- Safety concerns
- Lack of maintenance
- Overcrowding
- Lack of Amenities

- Option 6
- Other:

21. How can green spaces in your neighbourhood be improved

Your answer

22. How satisfied are you with your quality of life?*

Very satisfied

- 1
- 2
- 3
- 4
- 5

Very dissatisfied

23. Do you think that green spaces play an important role in improving your quality of life?*

- Yes
- No
- Maybe
- Other:

24. How do you intend to improve your quality of life?